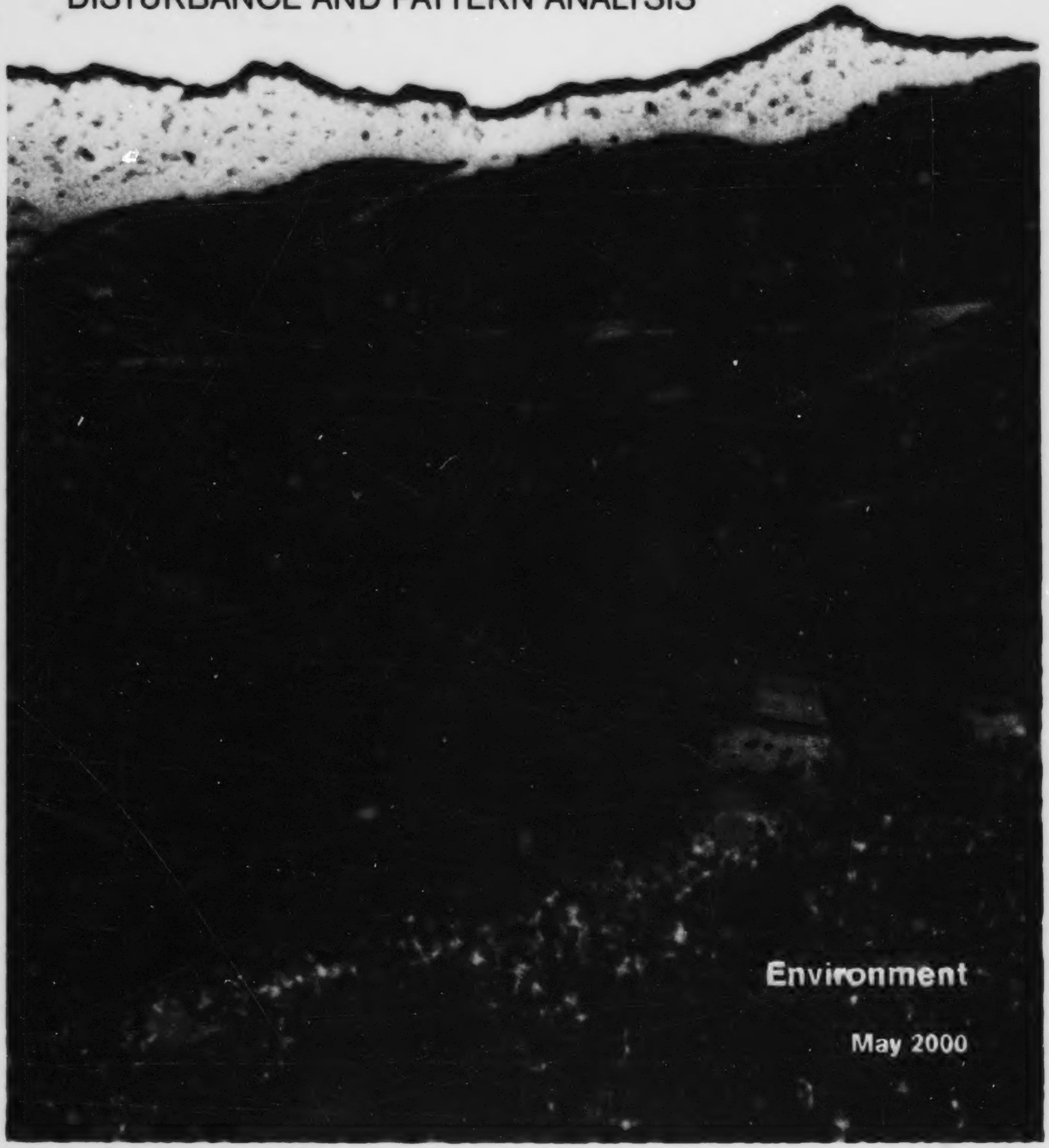
The Southern Rockies Landscape Planning Pilot Study

DISTURBANCE AND PATTERN ANALYSIS



Environment

May 2000

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Alberta
Environment
Land and Forest Service
Integrated Resource Management Division

OLSON
OLSON
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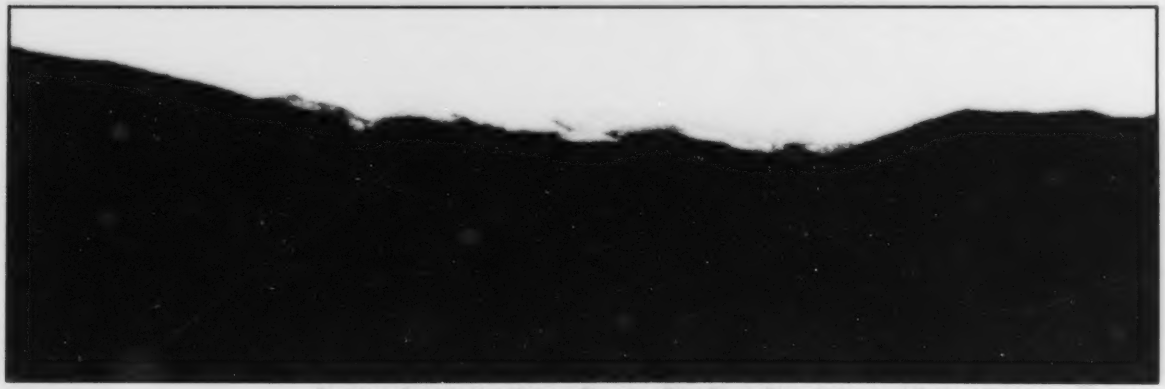


1.0 INTRODUCTION

Landscape planning based upon principles of landscape ecology and ecosystem management must have as one of its foundations a clear understanding of the processes that have shaped the landscape as well as the pattern and structure that those processes have produced. The relationship between pattern and process has been a major focus of many ecological studies (Wallin et. al., 1994; Turner, 1989; Borman and Likens, 1979). Flows and distributions of fire, water, nutrients, species, fibre and forage are closely tied to the spatial patterns of the landscape. These landscape patterns are produced and maintained by disturbance and recovery dynamics and controlled by climatic, physiographic and biotic conditions and processes.

Understanding and characterizing the heterogeneity in the landscape produced by inherent disturbance regimes is an important step in developing pattern objectives for both regions and landscape management units. A knowledge of the historical conditions is important in order to evaluate the sustainability of current and potential landscape patterns. As current forest practices involve a high level of uncertainty, in that the full impact of various management interventions are unknown or may not become apparent for many years, it is prudent to manage within the range of variability that has already occurred in the landscape. Historical patterns of heterogeneity should be followed or, at the very least, understood and acknowledged in order to reduce the risk of losing biodiversity and disrupting ecological processes (Turner et.al., 1994).

Characterizing landscape heterogeneity and inherent disturbance processes is the focus of this section of the Southern Rockies Landscape Planning Project. Landscape pattern and process evaluation and characterization requires analysis within a nested hierarchy of spatial and temporal scales. The scale of examination is dependent upon the process under evaluation. A hierarchical classification system has been used to define scales of analysis and will be used in future stages of the study to organize land pattern objectives.

1.1 SPATIAL HIERARCHY

Characterization of patterns and conditions was carried out by region, natural sub region and landscape as well as, in some cases, ecosite. While natural sub region has been examined, and has proved extremely useful in the delineation of landscape management units, it is not central to most of the analysis. Rather, the region and the landscape are the major focus of the work. The units of analysis are defined as follows:

1.1.1 REGION

A region is often considered as "a broad geographical area with a common macroclimate and sphere of human activity and interest." (Forman, 1995; Dickinson, 1970; Isard, 1975). The south eastern slopes region, in fact is much broader than the study area itself, extending south to the United States border and north to at least Banff National Park and including Kananaskis Country. For the purposes of this prototypical project, the study area, which is an fact sub regional in scale, is considered as the region. It includes those lands lying to the east of the continental divide and extending to the ranchlands west of Claresholm north to Kananaskis Country and south to approximately the Westcastle area (refer to location map). It includes the northern portion of the C5 forest management unit and covers 5058 km^2.

1.1.2 LANDSCAPE MANAGEMENT UNIT (LMU)

A landscape or LMU is a heterogeneous area in which the pattern of the mosaic of local ecosystems or land uses is repeated in similar form throughout a kilometers wide area (after Forman, 1986). It may coincide with a climatic, physiographic or ecological boundary. However, landscapes are not strictly ecologically based and include human use and modification of the area. Landscapes are areas which can be expected to respond to management interventions in a similar manner and have developed under relatively similar disturbance regimes (both human and natural disturbances). The landscapes on the accompanying Landscape Management Unit map were identified using the following input digital data sources:

Natural Sub Regions
Physical Land Classification @ 1:50 000
Ecological Land Classification @ 1:100 000
Digital Terrain Model
LANDSAT TM
Orthophotographs
Alberta Vegetation Inventory

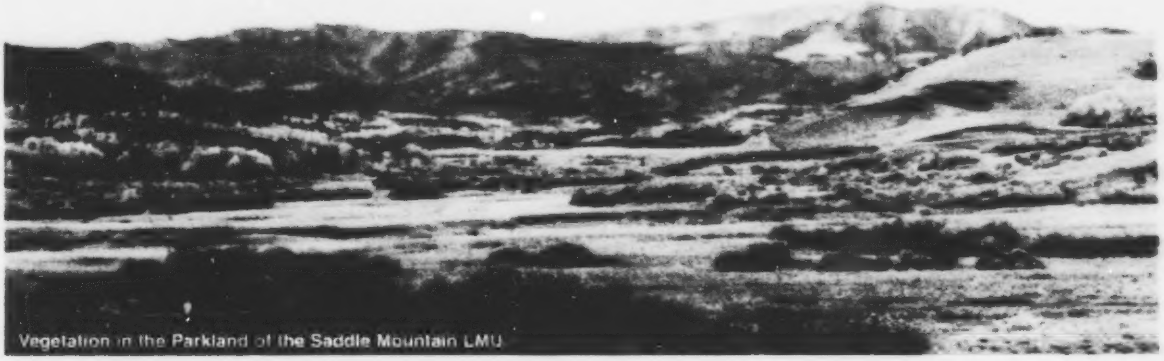
Wherever possible, landscapes have been delineated on the basis of natural sub region or physical or ecological boundaries. The boundaries have been set where a visible change in land cover pattern is clearly identified on either the Landsat or orthophoto imagery or the land cover map. Boundaries have also been identified where major flows of species, fire, water, etc. are interrupted, such as at the Livingstone Range. In most cases, the landscape delineation results in units that cross public/private land boundaries as long as the pattern is continued on both sides of the administrative boundary. Unity of pattern therefore is a defining characteristic of landscapes.

The landscapes also reflect a need to identify pragmatic planning areas. While further stratification within the various landscapes is possible, this could result in an unwieldy number of units which would ultimately be less useful for planning purposes. Therefore, some units that display a limited degree of vegetation composition difference (e.g., the north and south Porcupine Hills) were aggregated into one landscape unit. The following landscapes were delineated in the study area:

TABLE 1. LANDSCAPES OF THE STUDY AREA

Landscape	Area (ha)	% of Study Area
Alpine High Rock	8277	1.64%
Head Water Valleys	34,357	6.79%
Flathead	5351	1.06%
Crowsnest Pass	7628	1.51%
Middle Ridges	73,560	14.54%
Ironstone	8609	1.70%
Hillcrest	4740	0.94%
North Livingstone	37,960	7.50%
Livingstone Valley	7205	1.42%
South Livingstone	7888	1.56%
Beaver	7356	1.45%
Horseshoe Parkland	67,036	13.25%
Saddle Mountain	19,633	3.88%
Whaleback	39,524	7.81%
Chapel Rock	26,085	5.16%
South Fescue	29,170	5.77%
Porcupine Hills	81,560	16.12%
East Ranchlands	39,899	7.89%
TOTAL	**505,837**	**100%**

Riparian Vegetation in the Montane along the Oldman R



Vegetation in the Parkland of the Saddle Mountain LMU

Patchy Vegetation in the Montane of the Crowsnest Pass LMU.

1.1.3 ECOSITE PHASE

Ecosite Phase by maturity class (after Archibald et. al., 1996) is the smallest unit to be considered in the project and approximates the stand level scale. These patches represent the most detailed landscape classification and are used to describe both existing conditions and future scenarios. The ecosite phase is the vegetative expression on an ecosite. These local ecosystems have developed under similar environmental conditions (climate, moisture and nutrient regime). Ecosites are groups of one or more ecosite phases that occur within the same portion of the edatope (moisture/nutrient grid). Therefore, ecosites have similar landform, climate, nutrient and moisture regimes as well as potential vegetation, successional pathways, site productivity and, at a local scale, response to management. The procedure for identifying an ecosite phase has two stages; forest cover classification and subsequently, ecosite phase classification. The detailed methodology for both procedures is described in the Appendices 1, 2 and 3.

1.1.3.1 FOREST COVER CLASSIFICATION

The following 51 forest cover classes were identified in the study area. Forest cover is a classification of the Alberta Vegetation Inventory based upon conditional statements (listed in Appendix 3). The areal extent of the cover types in the region is listed below in Table 2.

TABLE 2. FOREST COVER CLASSES OF THE STUDY AREA

Cover Class	Area in hectares	% of Region
Pine	104,539	21.24%
Spruce	49,755	10.11%
Subalpine Fir	5840	1.19%
Douglas Fir	32,725	6.65%
Subalpine Larch	512	0.10%
Whitebark/Limber Pine	619	0.13%
Aspen	42,347	8.61%
Balsam Poplar	7139	1.45%

Aspen, spruce , aspen mix[illegible] and mesic grassland forest cover types near Chimney [illegible] in the Whaleback LMU.

TABLE 2. cont'd FOREST COVER CLASSES OF THE STUDY AREA

Cover Class	Area in hectares	% of Region
Aspen Mixedwood	7402	1.50%
Balsam Poplar Mixedwood	2026	0.41%
Pine Mixedwood	6709	1.36%
Spruce Mixedwood	2444	0.50%
Subalpine Fir Mixedwood	213	0.04%
Douglas Fir Mixedwood	2307	0.47%
Mixed Conifer (Pine)	24	0.00%
Mixed Conifer (Spruce)	674	0.14%
Mixed Conifer (True Fir)	416	0.08%
Mixed Conifer (Douglas Fir)	826	0.17%
Mixed Conifer (Whitebark/Limber Pine)	14	0.00%
Mixed Conifer (Larch)	2838	0.58%
Spruce Wetland	144	0.03%
Shrub Wetland	1272	0.26%
Shrub Meadow Open Mesic	4717	0.96%
Shrub Meadow Open Dry	1400	0.28%
Shrub Meadow Closed Mesic	8009	1.63%
Shrub Meadow Closed Dry	1876	0.38%
Rough Pasture Open Mesic	7623	1.55%
Rough Pasture Open Dry	2494	0.51%
Rough Pasture Closed Mesic	4391	0.89%
Rough Pasture Closed Dry	1016	0.21%
Wet Graminoid	319	0.06%
Annual Crops	1894	0.38%
Perennial Forage Crops	33,662	6.84%
Grassland Mesic	38,553	7.83%
Grassland Dry	92,531	18.80%
Gravel Pits/Surface Mines	725	0.15%
Rural Residential	137	0.03%
Hamlets, Villages and Towns	520	0.11%
Non—veg ROWs	782	0.16%
Farmsteads	455	0.09%
Plant Sites/Sewage Lagoons	100	0.02%
Rock Barren	14,534	2.95%
Cutbank/Sand	248	0.05%
River	91	0.02%
Lakes/Ponds	828	0.17%
Permanent Ice/Snow	31	0.01%
Industrial Reclamation—Vegetated	210	0.04%
Forb Meadow	323	0.07%
Flooded	77	0.02%
Bryophytic Pond	6	0.00%
Herbaceous Clearcuts	3739	0.76%
TOTAL	**492,076**	**100.00%**

Note: The deviation of forest cover total area from the total study area size is due to incomplete AVI data for the north eastern portion of the region.

1.1.3.2 ECOSITE PHASE CLASSIFICATION

Ecosite Phase classification preceded the identification of Ecosites. This was required as some elements of the AVI (notably moisture regime and soil conditions) were of questionable accuracy or lacking. Vegetation was therefore used as partially diagnostic of physiographic conditions. Ecosite phases were identified and subsequently collapsed into Ecosites. Archibald et. al., 1996, was the primary reference document for the ecosite phase classification.

In order to classify Ecosite Phase, the following data (all at 25m cell size) were utilized:

Alberta Vegetation Inventory
Digital Elevation Model
Aspect
Slope
Slope Position
Forest Cover
Natural Sub Regions
Physical Land Classification @ 1:50 000
Parent material and Soil Great Group

Individual models for each ecosite phase were developed based upon criteria for the map inputs. The results were draped over the digital terrain model, verified against the AVI and other input maps, evaluated by departmental experts and the models modified as necessary. Harry Archibald, Harry Stelfox, Mike Willoughby, Mike Alexander and Barry Adams assisted in the construction of the models. The models were produced and executed using the ERDAS Imagine 8.3 Spatial Modelling tool (refer to appendix for individual model descriptions). Each model was numbered in a manner consistent with the indexing system utilized in the reference document, Field Guide to Ecosites of Southwestern Alberta (Archibald et. al., 1994).

Models were designed for three natural sub regions, Subalpine (9 classes), Montane (12 classes) and Grasslands (17 classes). As boundaries between the sub regions were not always abrupt, additional classes,

False Azalea /Thimbleberry – Lodgepole Pine, Spruce / Heather Englemann Spruce North Continuous Fuels in the Middle Ridges LMU.

namely Transitional Subalpine (10 classes) and Transitional Montane (2 classes) regions, were subsequently identified and models were developed for them separately. The Montane models were applied to both the Foothills Parkland (12 classes) and Foothills Fescue (12 classes) regions. The following ecosite phases have been classified in the study area:

TABLE 3. ECOSITE PHASES OF THE STUDY AREA

ECOSITE PHASE	AREA (HA)	% of Region Classified
Lichen Lodgepole Pine (811)	5099.06	1.17%
Lichen Lodgepole Pine Hc (812)	13.88	0.00%
Bearberry/Hairy Wild Rye Lodgepole Pine (821)	19,369.50	4.43%
Bearberry/Hairy Wild Rye Hc (822)	204.19	0.05%
Subalpine Larch/Heather La—Fa (831)	3348.31	0.77%
Spruce/Heather Se North (841)	25,376.06	5.80%
Spruce/Heather Hc (842)	823.44	0.19%
False Azalea/Thimbleberry Pl (851)	52,858.50	12.08%
False Azalea/Grouseberry Whitebark Pine (852)	531.63	0.12%
False Azalea/Thimbleberry Se North (853)	18,242.06	4.17%
False Azalea/Thimbleberry Fa (854)	2140.38	0.49%
False Azalea Hc (855)	1895.13	0.43%
Horsetail Se (881)	885.50	0.20%
TS—Limber Pine/Juniper Fd—Pf (2911)	637.13	0.15%
TS—Bearberry Aspen (2922)	1215.81	0.28%
TS—Bearberry Aw—Sw—Pl (2923)	2581.75	0.59%
TS—Buffaloberry/Hairy Wild Rye Fd (2931)	591.38	0.14%
TS—Buffaloberry/Hairy Wild Rye Aw—Sw—Pl—Fd (2934)	1610.69	0.37%
TS—Creeping Mahonia White Meadowsweet Fd (2941)	2170.31	0.50%
TS—Creeping Mahonia White Meadowsweet Sw (2943)	681.44	0.16%
TS—Creeping Mahonia White Meadowsweet Hc (2944)	34.69	0.01%
TS—Thimbleberry Pine Grass Aw (2952)	2270.88	0.52%
TS—Balsam Poplar (2961)	1057.00	0.24%
TS—Horsetail Sw—Pb (2971)	77.69	0.02%
Limber Pine/Juniper Fd—Pf (911)	4253.25	0.97%
Limber Pine/Juniper Hc (912)	19.75	0.00%
Bearberry Lodgepole Pine (921)	8913.19	2.04%
Bearberry Aspen (922)	8666.94	1.98%
Bearberry Aw—Sw—Pl (923)	3804.75	0.87%
Bearberry Hc (924)	120.31	0.03%
Buffaloberry/Hairy Wild Rye Fd (931)	4080.13	0.93%
Buffaloberry/Hairy Wild Rye Hc (932)	13.69	0.00%
Creeping Mahonia White Meadowsweet Fd (941)	23,087.44	5.28%
Creeping Mahonia White Meadowsweet Pl (942)	20,197.06	4.62%
Creeping Mahonia White Meadowsweet Sw (943)	8324.94	1.90%
Creeping Mahonia White Meadowsweet Hc (944)	480.50	0.11%
Thimbleberry Pine Grass Aw (952)	20,060.44	4.59%
Thimbleberry Pine Grass Hc (953)	33.63	0.01%
Balsam Poplar (961)	4076.00	0.93%
Horsetail Sw—Pb (971)	924.06	0.21%
Horsetail Sw (972)	528.88	0.12%
TM—Subalpine Larch/Heather La—Fa (2831)	7.81	0.00%
TM—False Azalea/Thimbleberry Fa (2854)	266.50	0.06%
Rough Fescue Parkland (1400)	15,459.50	3.53%
Willow Groveland (1402)	9272.44	2.12%
Wet Sedge Meadow (1403)	318.19	0.07%

TABLE 3. cont'd ECOSITE PHASES OF THE STUDY AREA

ECOSITE PHASE	AREA (HA)	% of Region Classified
Dry Willow Montane (1404)	5248.56	1.20%
Wet Willow (1406)	1287.63	0.29%
Dry Willow Subalpine (1407)	704.56	0.16%
Rough Fescue Subalpine (1408)	7759.56	1.77%
Steep Hairy Wild Rye Subalpine (1409)	4618.44	1.06%
Wind Swept Ridges Subalpine (1410)	5516.56	1.26%
Wind Swept Ridges Alpine (1411)	3880.38	0.89%
Moist North Alpine (1412)	118.88	0.03%
Moist Southwest Alpine (1413)	66.63	0.02%
Rough Fescue Foothills (1433)	47,175.00	10.78%
Rough Fescue Montane (1934)	44,513.13	10.18%
Blue Bunch Wheatgrass (1935)	660.88	0.15%
Bearberry Grassland (1936)	16,818.06	3.84%
Pinegrass Hairy Wild Rye (1937)	844.31	0.19%
PK—Limber Pine/Juniper Fd—Pf (3911)	12.81	0.00%
PK—Bearberry Lodgepole Pine (3921)	149.19	0.03%
PK—Bearberry Aspen (3922)	3487.38	0.80%
PK—Bearberry Aw—Sw—Pl (3923)	481.81	0.11%
PK—Buffaloberry/Hairy Wild Rye—Fd (3931)	21.25	0.00%
PK—Creeping Mahonia White Meadowsweet Fd (3941)	224.25	0.05%
PK—Creeping Mahonia White Meadowsweet Pl (3942)	374.69	0.09%
PK—Creeping Mahonia White Meadowsweet Sw (3943)	1847.75	0.42%
PK—Thimbleberry Pine Grass Aw (3952)	10,165.13	2.32%
PK—Balsam Poplar (3961)	2206.88	0.50%
PK—Horsetail Sw—Pb (3971)	395.31	0.09%
PK—Horsetail Sw (3972)	65.94	0.02%
FF—Limber Pine/Juniper Fd—Pf (4911)	15.50	0.00%
FF—Bearberry Lodgepole Pine (4921)	16.69	0.00%
FF—Bearberry Aspen (4922)	223.38	0.05%
FF—Bearberry Aw—Sw—Pl (4923)	37.50	0.01%
FF—Buffaloberry/Hairy Wild Rye Fd (4931)	8.75	0.00%
FF—Creeping Mahonia White Meadowsweet Fd (4941)	248.25	0.06%
FF—Creeping Mahonia White Meadowsweet Pl (4942)	61.38	0.01%
FF—Creeping Mahonia White Meadowsweet Sw (4943)	135.19	0.03%
FF—Thimbleberry Pine Grass Aw (4952)	710.25	0.16%
FF—Balsam Poplar (4961)	593.94	0.14%
FF—Horsetail Sw—Pb (4971)	124.81	0.03%
FF—Horsetail Sw (4972)	2.31	0.00%
TOTAL	**437,448.63***	**100.00%**

* **Note:** Deviation from total study area is due to non classification of the following cover types:

Annual Crops
Perennial Forage Crops
Gravel Pits/Surface Mines
Rural Residential
Rock Barren
River
Permanent Ice/Snow
Industrial Reclamation—Vegetated
Plant Sites/Sewage Lagoons
Non—veg ROWs
Farmsteads
Hamlets, Villages and Towns
Cutbank/Sand
Lakes/Ponds
Flooded
Bryophytic Pond

1.1.3.3 ECOSITE CLASSIFICATION

Following ecosite phase classification, phases with the same prefix were assigned to an ecosite (e.g., the following ecosite phases: Bearberry Lodgepole Pine, Bearberry Aspen, Bearberry Aw—Sw—Pl were all classified as Bearberry Ecosite). Ecosites classified in the study area include:

TABLE 4. ECOSITES OF THE STUDY AREA

Ecosite	Area (ha)	% of Region
Lichen	5147	1.18%
Bearberry/Hairy Wild Rye	19,525	4.46%
Subalpine Larch/Heather	3388	0.77%
Spruce/Heather	26,341	6.02%
False Azalea	76,300	17.44%
Horsetail SA	885	0.20%
Limber Pine/Juniper	4933	1.13%
Bearberry	29,706	6.79%
Canada Buffaloberry/Hairy Wild Rye	6277	1.43%
Creeping Mahonia—White Meadowsweet	58,097	13.28%
Thimbleberry/Pine Grass	33,363	7.63%
Balsam Poplar	7979	1.82%
Horsetail MN	2129	0.49%
Rough Fescue Parkland	15,678	3.58%
Willow Groveland	9293	2.12%
Wetlands	320	0.07%
Dry Willow Montane	5272	1.21%
Wet Willow	1294	0.30%
Dry Willow Subalpine	706	0.16%
Rough Fescue Subalpine	7600	1.74%
Steep Hairy Wild Rye Subalpine	4550	1.04%
Windswept Ridges Subalpine	5223	1.19%
Alpine Exposed	3893	0.89%
Moist Shrubland	120	0.03%
Arctic Willow	66	0.02%
Rough Fescue Foothills	47,185	10.79%
Rough Fescue	45,404	10.38%
Blue Bunch Wheatgrass	613	0.14%
Bearberry Grassland	15,404	3.52%
Pinegrass Hairy Wild Rye	758	0.17%
TOTAL AREA CLASSIFIED	**437,447**	**100.00%**

Ecosites to the east of the Livingstone Gap: bluebunch wheatgrass and bearberry grassland ecosites on and near the ridge tops in the middle ground; rough fescue ecosites in the valley bottom [illegible] mahonia white [illegible] ck ridge; the Porcupine Hills are in the distance.

2.0 DISTURBANCE ANALYSIS

Landscape patterns and processes are closely related to disturbance regimes. In the Southern Rockies study area, fire, insects, disease, wind, avalanches and landslides are the major natural disturbances that have occurred for thousands of years and which have given rise to the current landscape structure. Until recent years when fire control has become effective, the overwhelming mechanism for disturbance and subsequent forest origin in the Southern Rockies was fire (Johnson, E.A. and G.I. Fryer, 1987; Day, 1972). The landscape pattern has also been heavily modified by humans. The major current and historic human disturbance influences, listed in order of magnitude and extent, are: perennial forage crops, logging, annual crops, road and trail construction, grazing, oil and gas exploration / production / transmission, coal mining and recreational camping. Records of historic logging in the area are very limited and while there certainly was harvesting before the turn of the century, its extent is not well mapped. The disturbance analysis in subsequent sections is based on analysis of the Alberta Vegetation Inventory stand origin data. It is recognized that this data gives only a partial picture of all landscape disturbances, particularly fire. However, the origin data provides a good "indicator" of the disturbance regime and clearly indicates the differences across the landscape. Further, more detailed and costly studies may be necessary in some areas depending on management objectives.

2.1 FIRE

Fire has played the major role in shaping the unmanaged forest from prehistoric times to the advent of effective fire control in the 1960s. Fire has also been the dominant disturbance force in the grassland and shrub

Fire has been the main disturbance agent in the study area communities of the foothill parklands and prairies. Despite its importance, to date, little fire research and analysis has been carried out in the southern ranges of the Rocky Mountains in Canada with some exceptions (Barrett 1996, Bloomberg 1950, Day 1972, Johnson and Fryer 1987, Bessie and Johnson 1995, Johnson and Larsen 1991, Johnson et. al. 1994, 1995, McMillan 1909, Masters 1990, Murphy 1996 and others).

The forest landscape mosaic consists of patches of varying age since the last disturbance (stand origin). In the study area, the map of forest stand origin is almost exclusively controlled by the fire cycle and indicates the spatial distribution of the time since the last stand replacing fire. The source of the stand origin data is the Alberta Vegetation Inventory (AVI) which is estimated from aerial photographs with a limited amount of field verification. Origin is classified by decade and patches of a single age class may in fact have been the result of more than one disturbance during the decade. While use of the AVI stand origin data as a facsimile for time since the last stand replacing fire is appropriate for most of the stands, it may not be correct for those stands of uneven—aged structure (e.g., some areas in the Head Water Valleys, particularly Englemann spruce/pine stands or spruce/fir stands). Nevertheless, AVI stand origin has been used for all forested areas.

While records of fire incidence and cause during the earlier part of this century are incomplete, detailed records of all fires between 1961 and 1995 have been analysed by the Fire Management Planning Team (1998). The study found that lightning accounts for only 22% of all fires in the area, far lower than the provincial average. The numbers are likely skewed in favour of man caused fires due to the fact that the area is heavily visited by recreationists. All known fire starts in the area have been mapped. Lightning caused fires are not distributed randomly and the highest incidence occurs in the Porcupine Hills where over 38% of all fires are lightning caused. This is followed by the Middle Ridges at 18%. Man caused fires tend to be clustered around areas of settlement and along major access roads.

One of the major limitations of this analysis is that it does not include low to moderate intensity fires or multiple (mixed) intensity fires. The data only indicates the origin of the stand and does **not** account for fires that did not replace the stand (e.g., ground fires that simply eliminated fine fuels and some of the trees). Detailed charcoal and snag studies will be required to both verify the number of non stand replacing fires as well as to understand the composition of stands prior to the last burn. It is anticipated that these studies will be carried out in the area but they are beyond the scope of the present study.

2.1.1 REGIONAL SCALE EVALUATION OF DISTURBANCE BY FIRE

Disturbance analysis is required for at least two scales, namely the region and the landscape. Overall regional patterns and processes are extremely important as most disturbance processes operate at scales beyond that of the landscape or landscape management unit. The following are the regional disturbance analyses results:

2.1.1.1 AGE CLASS DISTRIBUTION

The stand origin decade is assumed to be the date of stand replacement by fire. In this region, fire is overwhelmingly the mechanism of stand origin. The following table and chart indicates distribution of age classes across the entire region. There are 40 different age classes. The oldest stands are in the 1600 — 1610 class.

TABLE 5. REGIONAL AGE CLASS DISTRIBUTIONS

Decade of Origin	Area in ha Using Current Data	Area in ha Using Inferred Data	Percent of Forest Area Current Data	Percent of Forest Area Inferred Data
1600 to 1609	51	51	0.02%	0.02%
1610 to 1619	165	165	0.06%	0.06%
1620 to 1629	0	0	0.00%	0.00%
1630 to 1639	27	40	0.01%	0.01%
1640 to 1649	0	0	0.00%	0.00%
1650 to 1659	123	124	0.05%	0.05%
1660 to 1669	458	481	0.17%	0.18%
1670 to 1679	202	202	0.07%	0.07%
1680 to 1689	0	0	0.00%	0.00%
1690 to 1699	24	24	0.01%	0.01%
1700 to 1709	343	378	0.13%	0.14%
1710 to 1719	622	655	0.23%	0.24%
1720 to 1729	1664	1763	0.62%	0.65%
1730 to 1739	318	381	0.12%	0.14%
1740 to 1749	1858	1944	0.69%	0.72%
1750 to 1759	302	326	0.11%	0.12%
1760 to 1769	1316	1426	0.49%	0.53%
1770 to 1779	4655	5251	1.73%	1.95%
1780 to 1789	892	897	0.33%	0.33%
1790 to 1799	2080	2114	0.77%	0.78%
1800 to 1809	3654	3768	1.36%	1.40%
1810 to 1819	625	625	0.23%	0.23%
1820 to 1829	1168	1220	0.43%	0.45%
1830 to 1839	491	502	0.18%	0.19%
1840 to 1849	3158	3158	1.17%	1.17%
1850 to 1859	1404	1465	0.52%	0.54%
1860 to 1669	7372	7752	2.74%	2.88%
1870 to 1879	18,035	18,401	6.69%	6.83%
1880 to 1889	15,359	15,612	5.70%	5.79%
1890 to 1899	27,819	28,069	10.32%	10.41%
1900 to 1909	20,423	20,510	7.58%	7.61%
1910 to 1919	58,976	59,178	21.88%	21.96%
1920 to 1929	38,556	38,736	14.31%	14.37%
1930 to 1939	24,429	24,460	9.06%	9.08%
1940 to 1949	15,372	15,375	5.70%	5.70%
1950 to 1959	8949	8988	3.32%	3.33%
1960 to 1969	5225	5497	1.94%	2.04%
1970 to 1979	2531	2671	0.94%	0.99%
1980 to 1989	852	904	0.32%	0.34%
1990	16	16	0.01%	0.01%

FIGURE 1. REGIONAL AGE CLASS DISTRIBUTION IN HECTARES

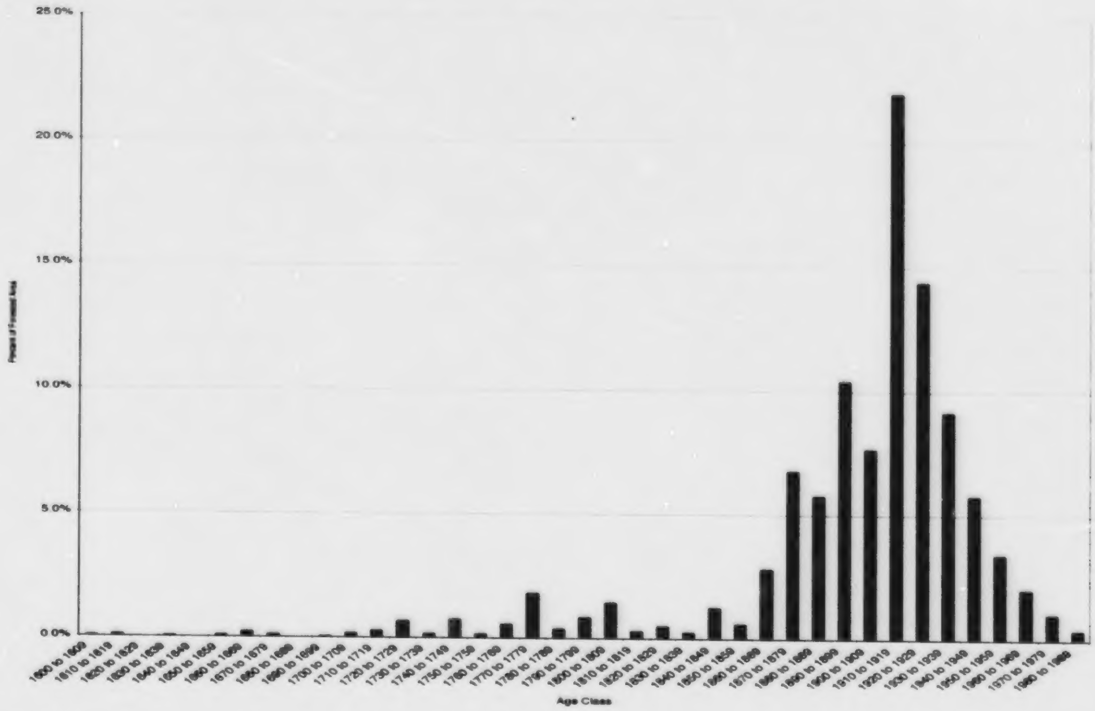


Table 5 and Figure 1 reflect values for both current and inferred data. The current data source is the AVI origin interpretation, while the inferred data is obtained by filling in the cutblock cell values with the most frequently occurring origin values adjacent to the block. The latter operation was carried out in order to compare the effect of recent cutting on the age class structure. When viewed at the regional level, the difference between the current and inferred age class origin is very slight. The extent of logging in the region to date is not great when compared to the extent of fires during similar time periods. However, most of the logging has been concentrated in the upper Head Water Valleys which escaped the majority of the large fires of the last century. Harvesting has been far more extensive in the Head Water Valleys than in any other portion of the landscape.

The vast majority (87.3%) of the forested area falls in the age classes with origins between 1860 and 1950. Almost all stands in the area are of fire origin. The area is subject to extremely large fire events during short periods of time with 55% of the forested area burnt during the period 1890 —1930 and 22% burnt in the decade 1910—1919 alone. The map of fires between 1890 and 1920 demonstrates the extent of those conflagrations.

McMillan (1909) describes conditions in the Crowsnest Pass in the early part of the century as follows:

"Thus of a possible forest area of 212 square miles only 16% remains unburned, 28% has been burned over and is bearing another crop, 16% is covered with timber which has been killed by fire and from 40% or nearly half the total area the timber has been so completely removed by fire that a worthless grass cover or bare rock now takes its place." (McMillan, 1909)

Whether the extremely large fire events which occurred over a relatively short period of time at the turn of the century were anomalies is uncertain. However, given the ecology of the leading tree species in the region, the fact that most of the area is adapted to periodic fire events is difficult to dispute. It is more problematic to discern

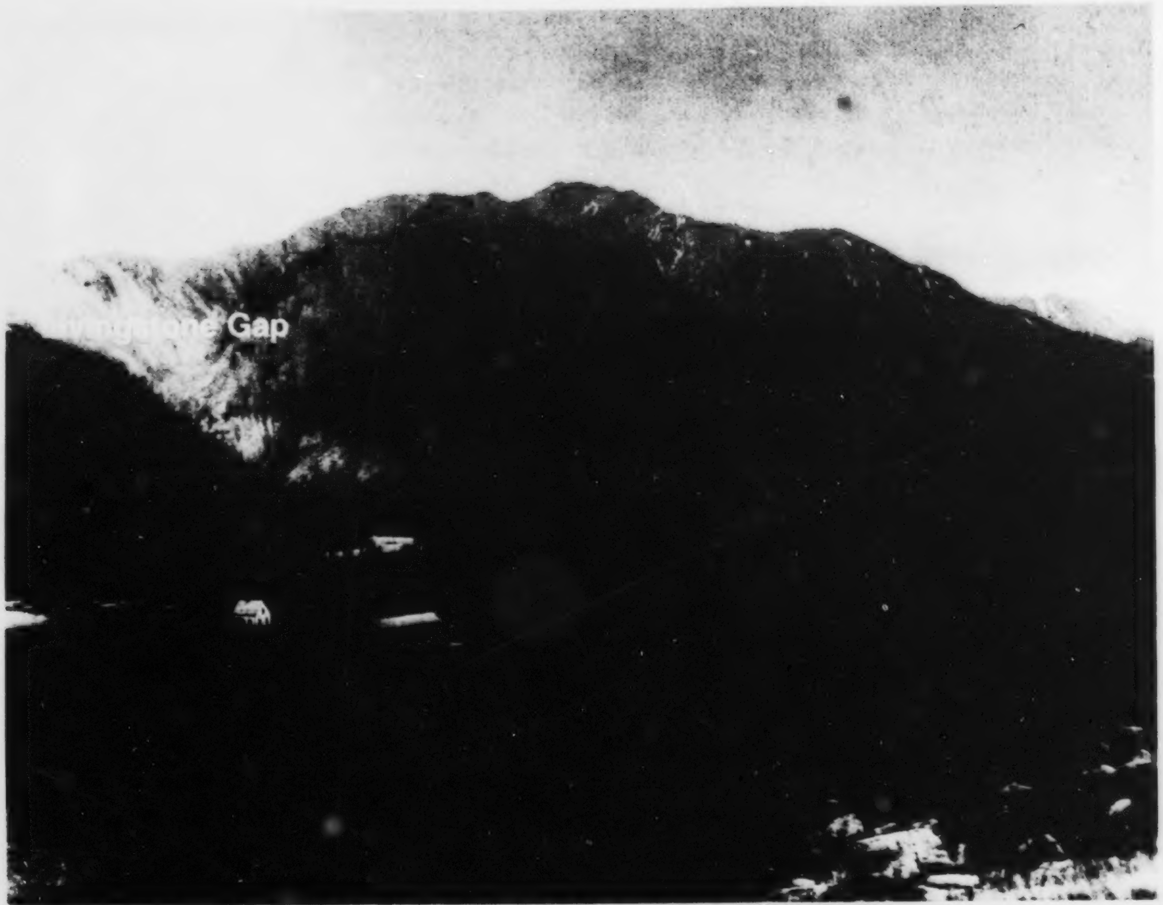


FIGURE 2. THE LIVINGSTONE GAP RANGER STATION AND ENVIRONS IN 1920 (ILLUSTRATING THE EXTENSIVE BURNS IN THE AREA)

how indicative the large burns are of the last several centuries of disturbance history. The period of very large burns (1890 — 1920) coincides not only with an extended dry period around the turn of the century, but also with increased human settlement and activity in the area. Without further field investigations, it is not possible to confirm if the current disturbance patch size distribution is representative of prehistoric events.

2.1.1.2 RECALCULATED AGE CLASS DISTRIBUTION — 1990 AND 1950

In order to assess changes in age class distribution over time, a roll back of ages to reflect ages of stands in 1950 (approximately the start of intensive fire control) was carried out. As stands that had an origin since that time were not able to be rolled back, the total area of stands in 1950 was less than for 1990. The two age class distributions are compared on the adjacent chart as a percentage of the forested stands in the region. It is very apparent that a shift in the age class distribution has occurred and has resulted in an older forest on the current landscape. This is to be expected given the fact that very few large events have occurred in the last 50 years and the area of burning has been small. The area weighted average age of the forest can be expected to increase in the future unless disturbance (fire or logging) extent also increases.

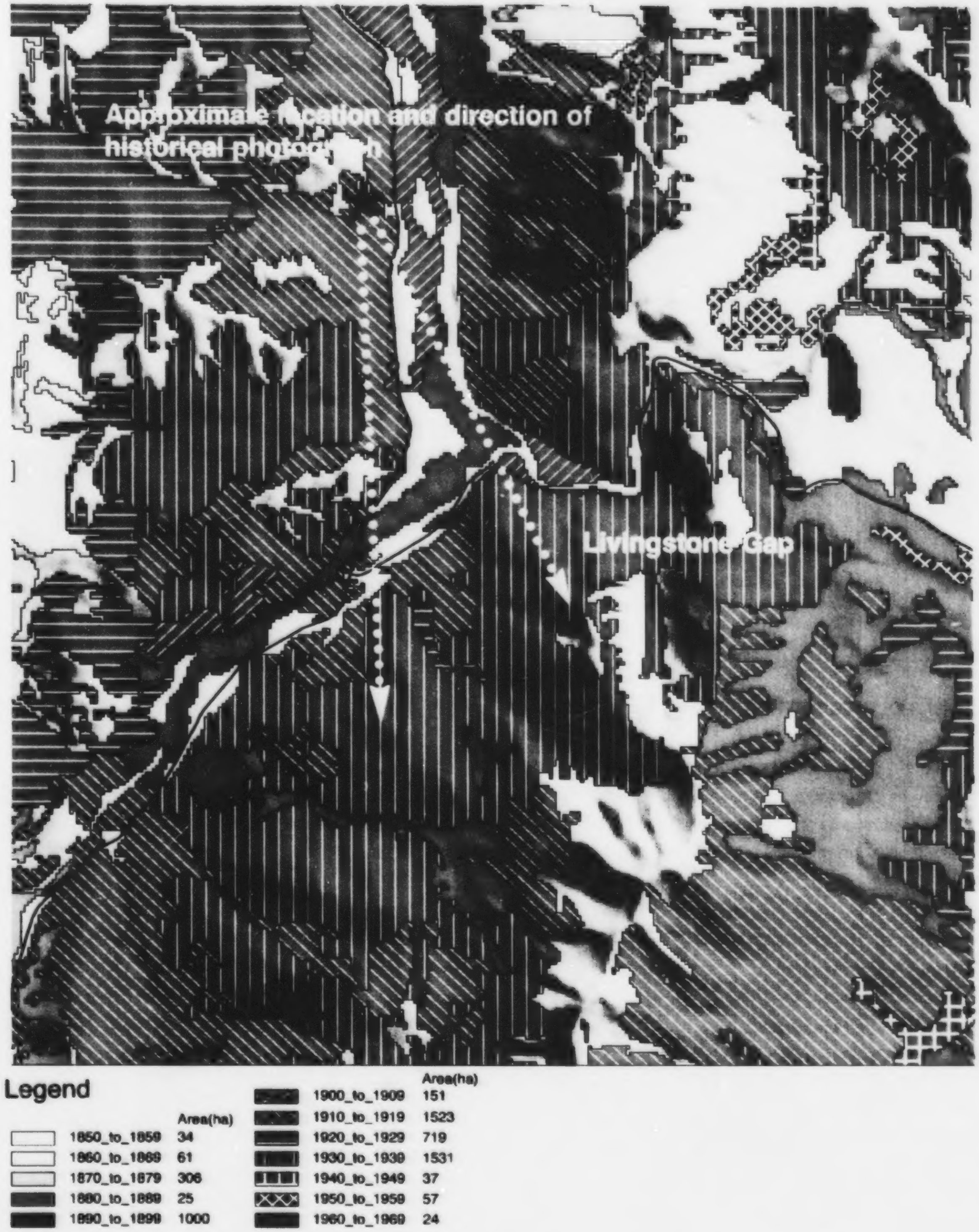

Approximate location and direction of historical photograph
Livingstone Gap
Legend
Area(ha)
1850_to_1859 34
1860_to_1869 61
1870_to_1879 306
1880_to_1889 25
1890_to_1899 1000
Area(ha)
1900_to_1909 151
1910_to_1919 1523
1920_to_1929 719
1930_to_1939 1531
1940_to_1949 37
1950_to_1959 57
1960_to_1969 24

FIGURE 3. DISTURBANCE PATCHES IN THE VICINITY OF LIVINGSTONE FIELD STATION INDICATING MULTIPLE LARGE EVENTS

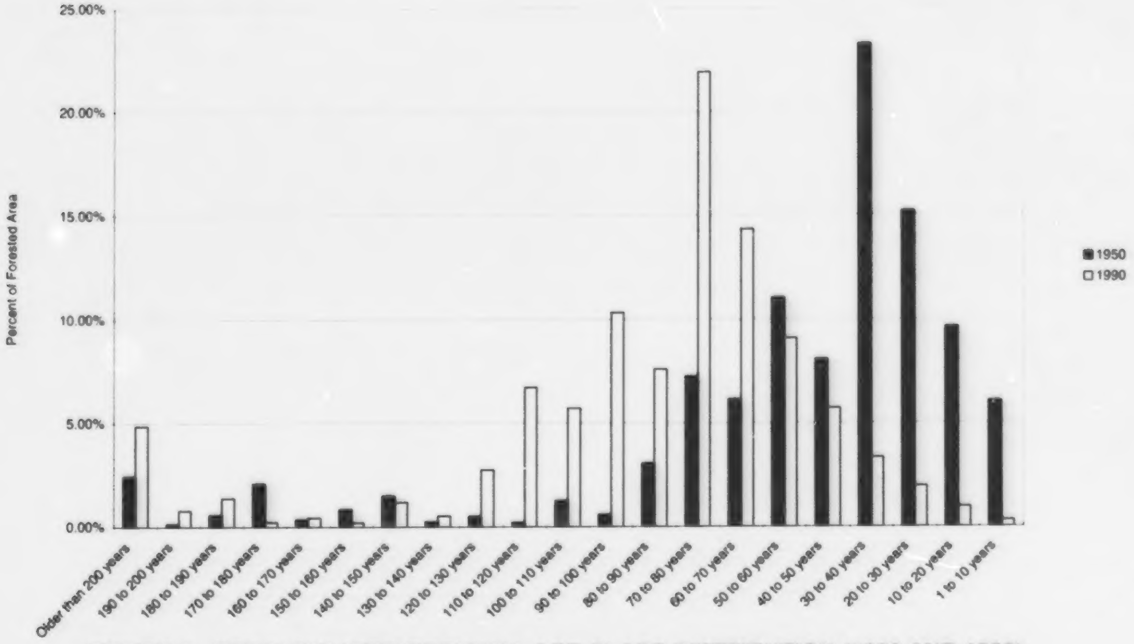


FIGURE 4. RECALCULATED REGIONAL AGE CLASS DISTRIBUTION (1950 AND 1990)

2.1.1.3 OLD GROWTH FOREST

While old growth forest is a generally accepted concept (Spies and Franklin 1988), it is usually not defined strictly by chronological age, but may also be characterized by structural and functional conditions such as large trees, variation in size classes, dead standing trees, large downed woody debris, multiple canopy layers, cessation of height growth of oldest trees, etc. (Johnson, et. al., 1995).

As much of this data is unavailable in the study area, old growth forest has been defined as stands older than 200 years. These stands account for only 5.6% of the total forested lands or 15,100 ha and are indicated on the map of old growth forest. Most of these stands are located in the cooler, more moist Head Water Valleys adjacent to or near the main Rocky Mountain Ranges. Recent logging has concentrated in these areas and have removed many stands. Many that remain are heavily fragmented. The oldest identified stand in the region is located in the Middle Ridges and has an origin of 1600 — 1609. Cutting is currently taking place immediately adjacent to it and the stand will likely be removed on the next pass.

2.1.1.4 REGIONAL FIRE CYCLE

The fire cycle is defined as the length of time it takes to burn an area equal to the entire area of interest. This does **not** mean that every area is burned during a fire cycle. Some areas may burn repeatedly while others do not burn at all during the period. The fire cycle was calculated for the entire study area as well as for the individual landscape management units by the Fire Management Planning team (1998). Three methods of calculation were used in that study. However, the results below utilize the average area weighted age of the forest which was considered to be statistically defensible. The following table summarizes the results.

The fire cycle of the region using both current and inferred data was calculated using the following formula:

Fire Cycle = SUM of [(Stand1 area * Stand1 age) + (Stand2 area * Stand2 age) + (Stand3 area * Stand3....n age)]
where:
n = number of stands
stand area is calculated as a percentage of total forested land
stand age is calculated as 1990 – origin date

The fire cycle has been calculated using the area weighted method for the entire study area as well as the Natural Sub Regions (NSR) of the area. The following are the results:

Total Study Area	95 years
Subalpine NSR	108 years
Montane NSR	85 years
Foothills Parkland NSR	69 years
Foothills Fescue NSR	69 years

The subalpine has the longest fire cycle. This is further demonstrated in the landscape management unit analysis of fire cycles where subalpine landscapes have the longest cycles (refer 2.1.2.4).

2.1.1.5 NUMBER OF DISTURBANCE PATCHES

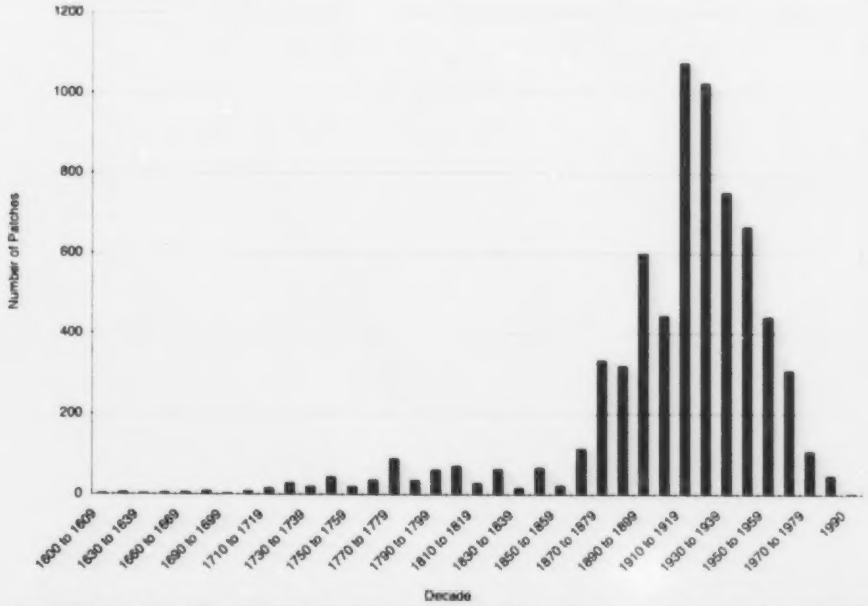


FIGURE 5. NUMBER OF CONTIGUOUS DISTURBANCE PATCHES BY DECADE IN THE REGION (SIZE OF PATCH NOT CONSIDERED)

The number of contiguous disturbance patches per decade of origin is indicated in the chart above. These were calculated by clumping contiguous areas of the same origin using the assumption that the decade of origin assigned to the patch was one disturbance event (the contiguity rules assigned pixels to the same patch if they touched including on the bishops diagonal). As origin data is only available by decade, it is possible that what is indicated as one contiguous patch with a single decade of origin could have been the result of several small but adjacent events. This possibility was not addressed in the analysis. A total of 6824 different contiguous disturbance patches were identified in the study area. The decade with the most patches (regardless of size) is 1910 to 1919 which coincides with a period of extensive as well as frequent burning. The chart is somewhat misleading as many of the fires of the period 1870 to 1950 consumed patches of earlier origin and the frequency of events of earlier dates is not accurately represented.

As Johnson et. al. (1995) put it, "at any point in time, the landscape mosaic will consist of only the most recent disturbance in its entirety and the remaining fragments of earlier disturbances." However, the chart does indicate that the frequency of events drops off dramatically in the 1970s.

2.1.1.6 DISTURBANCE PATCH SIZE

The size of individual disturbance events was also calculated. The original origin map using the inferred data to fill in recent cutblocks was clumped to identify contiguous areas of the same origin decadal class. The clumped map was then grouped into the following 8 size classes:

<2 ha	0.25%
>2 and <= 10 ha	5.26%
>10 and <= 50 ha	21.76%
>50 and <= 250 ha	27.55%
>250 and <= 1000 ha	21.03%
>1000 ha and <= 5000 ha	18.28%
>5000 ha and <= 10,000 ha	0.00%
>10,000 ha	4.74%

Fully 45% of the region's forested area belong to disturbance patches over 250 hectares with almost 25% belonging to patches over 1000 ha. There were only 25 patches over 1000 ha and these account for 24% of the entire forested area. One patch accounted for the area over 10,000 ha and that was the largest disturbance patch at 12,777 ha. This was a fire that burned in the Upper Oldman drainage in the decade of 1910 to 1919 (refer to map). The fire burned across several landscapes; the Head Water Valleys, the Middle Ridges, the Livingstone Valley and the North Livingstone. All 25 of the patches over 1000 ha are listed below, together with their decade of occurrence. The 25 patches are also indicated on the large fire map. All but one of these fires occurred in the subalpine area. Only one large fire (the smallest of those over 1000 ha — 1029 ha) occurred in the Porcupine Hills. Interestingly, no disturbance events were found in the class 5000 to 10,000 ha in extent.

Recent field work in the Middle Ridges LMU indicates that some AVI stand origin estimates may be incorrect. Stands which had been shown to have age differences of up to 30 or more years, in fact, were of the same age. Interpreters were noting differences in stand heights and assuming it was due to an age difference and not to the physical site limitations to growth. The results of this preliminary study indicate that disturbance patch size, already indicating very large events, may have been underestimated.

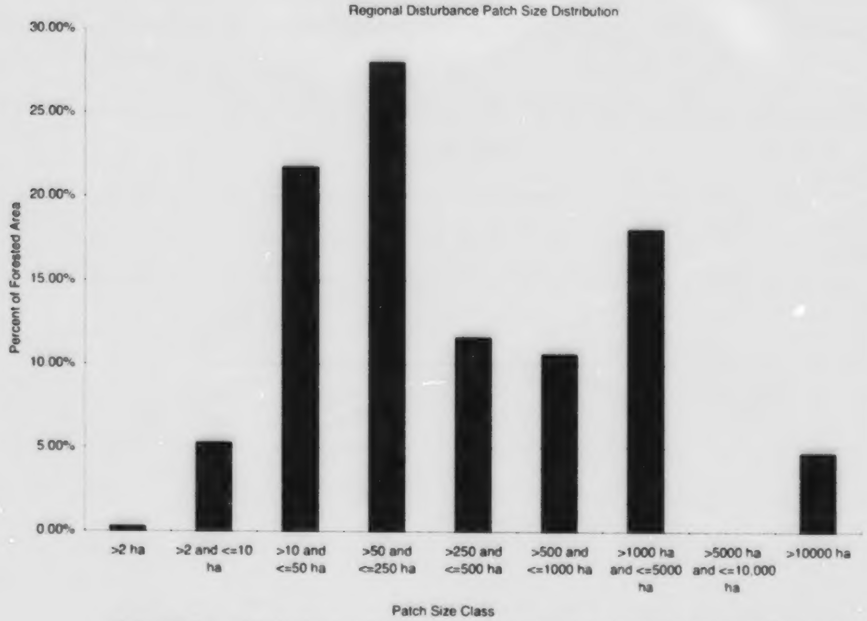


FIGURE 6. REGIONAL DISTURBANCE PATCH SIZE DISTRIBUTION

Although periods of prolonged drought occurred since the advent of intensive fire control in the 1950s, the last fire event over 1000 ha occurred in the decade 1930 to 1939. This has been despite the fact that a high number of patches originated since 1950. While fire control coincides with this time period and appears to have been effective in preventing large fires, this may not be the case. The possibility still exists that very large fire event periods are rare events that would have been uncontrollable had they occurred.

TABLE 6. LARGE DISTURBANCE PATCHES OVER 1000 HA AND THEIR DECADE OF ORIGIN (25 total in study area)

Size of Fire (ha)	Decade of Occurrence
12,777	1910 to 1919
4372	1910 to 1919
4185	1910 to 1919
3893	1860 to 1869
3479	1910 to 1919
3162	1900 to 1909
2351	1920 to 1929
2197	1890 to 1899
2141	1900 to 1909
2062	1870 to 1879
1939	1930 to 1939
1836	1930 to 1939
1771	1930 to 1939
1699	1920 to 1929
1610	1920 to 1929
1517	1920 to 1929
1485	1920 to 1929
1451	1880 to 1889
1345	1920 to 1929
1235	1880 to 1889
1192	1870 to 1879
1173	1870 to 1879
1071	1880 to 1889
1058	1880 to 1889
1029	1920 to 1929

As the number and size of patches persisting from any particular decade will depend upon the sizes and frequencies of both earlier and later fires, the current "snapshot" that has been used as the basis for most of the analysis is not necessarily indicative of a process or general cycle that is constant over a very long period of time. Larger fires that occur infrequently could mask conditions in which much smaller events created an extensive pattern of smaller patches. This possibility makes the analysis of both number of patches per decade as well as that of disturbance patch size a characterization of a single point in time.

Field work within the known disturbance patches would be required to reconstruct the inherent fire cycle under natural conditions over centuries if not millenia of time. Such work is costly and not likely to be undertaken over other large areas of land in the province. As the current project mandate is to develop tools that may be used for forest landscape planning throughout the province, and as it is likely that stand origin data from AVI interpretation will be the main source of data for disturbance analysis, this "snapshot" approach was considered practical and informative enough to be used for general forest level planning.

2.1.1.7 DISTURBANCE PATCH SHAPE

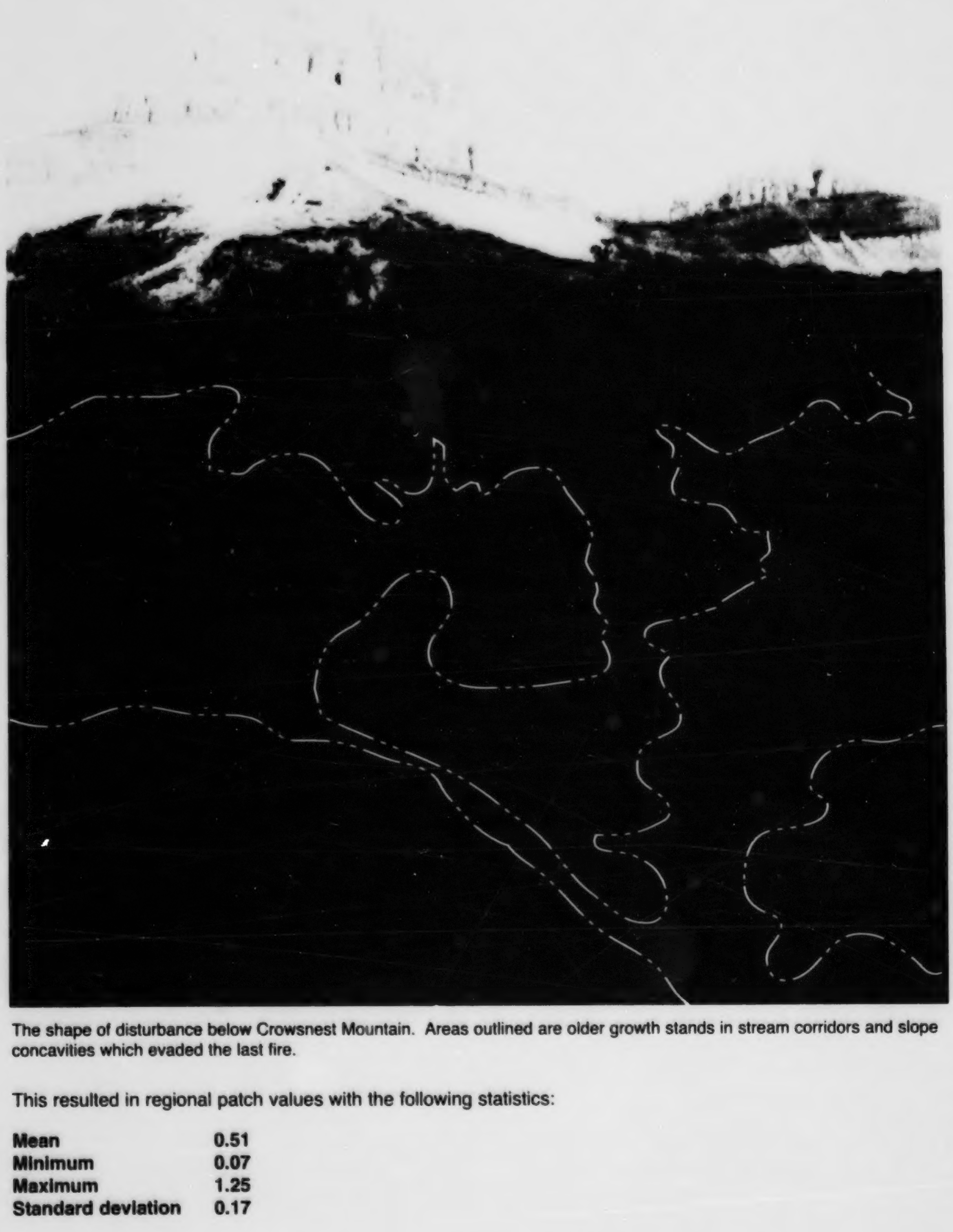
Even in areas of homogenous fuels, fires burning in mountainous terrain burn irregular shapes that respond to fuel types, topography and moisture conditions. The adjacent photo indicates the residual areas after the last major disturbance in the valley. Stream corridors and areas of slope concavity where fuel moisture levels are higher, evaded the last fire. Note the curvilinearity and interlocking nature of the mosaic with its coves and lobes. These are shapes that encourage inter—patch flows (Forman, 1995).

The convoluted nature of most of the patches in the region are typical of patches in mountainous areas. These tend to be more curvilinear in steeply sloping lands than on the prairies where patch edges tend to be much smoother. Variability of shape between also tends to be greater in the mountains. Shape has important implications. It has been linked to human modification of landscapes (i.e., rectilinear cutblocks). The most natural patches with the lowest human modification tend to be those which are intermediate in terms of elongation, convolution and shape variance (Forman, 1995). Others have indicated that those areas of highest compaction tend to be the most stable patches. Patch shape has many important ecological implications including inter—patch flow control, interception of species, amount of interior core, use of both edge and interior by wildlife. However, these have yet to be correlated in the study area. The shape of contiguous patches of the same disturbance age (which may contain many stands) has been examined with two common measures, circularity and compactness. It must be noted however, that the shape analysis was based upon the AVI origin polygons. Horizontal structure such as small remnant islands within the patch are not identified in a spatially explicit manner and therefore shape indicies cannot consider it. It is recognized that additional stand interpretation is required in order to fully assess patch shape.

The map of contiguous disturbance patches was analyzed by calculating compactness (K_1) of a patch as:

$$K_1 = \frac{2\sqrt{\pi A}}{p}$$ (Bosch 1978, Davis 1986)

where: A = area and p = perimeter



The shape of disturbance below Crowsnest Mountain. Areas outlined are older growth stands in stream corridors and slope concavities which evaded the last fire.

This resulted in regional patch values with the following statistics:

Mean	**0.51**
Minimum	**0.07**
Maximum	**1.25**
Standard deviation	**0.17**

TABLE 7. COMPACTNESS OF DISTURBANCE PATCH BY REGION AND LMU

REGION (STUDY AREA)

Compactness Coefficient Class	% of LMU	Hectares
> 0 to 0.24	45.32	123,657.125
> 0.24 to 0.41	34.69	94,648.875
> 0.41 to 0.58	14.6	39,830.25
> 0.58 to 0.75	4.81	13,135.688
> 0.75 to 0.92	0.58	1573.125

ALPINE HIGH ROCK

Compactness Coefficient Class	% of LMU	Hectares
> 0 to 0.24	37.09	704.5
> 0.24 to 0.41	41.96	796.938
> 0.41 to 0.58	13.48	256.062
> 0.58 to 0.75	6.46	122.688
> 0.75 to 0.92	1.02	19.312

BEAVER

Compactness Coefficient Class	% of LMU	Hectares
> 0 to 0.24	43.47	2425.375
> 0.24 to 0.41	37.29	2080.625
> 0.41 to 0.58	14.79	825.188
> 0.58 to 0.75	4.08	227.625
> 0.75 to 0.92	0.38	20.938

CHAPEL ROCK

Compactness Coefficient Class	% of LMU	Hectares
> 0 to 0.24	16.1	883.75
> 0.24 to 0.41	51.42	2822.75
> 0.41 to 0.58	24.67	1354.25
> 0.58 to 0.75	7.13	391.625
> 0.75 to 0.92	0.67	36.75

CROWSNEST PASS

Compactness Coefficient Class	% of LMU	Hectares
> 0 to 0.24	39.83	1861.375
> 0.24 to 0.41	45.15	2109.938
> 0.41 to 0.58	11.36	530.875
> 0.58 to 0.75	3.14	146.688
> 0.75 to 0.92	0.52	24.25

EAST RANCHLANDS

Compactness Coefficient Class	% of LMU	Hectares
> 0 to 0.24	11.79	154.125
> 0.24 to 0.41	51.29	670.312
> 0.41 to 0.58	24.47	319.75
> 0.58 to 0.75	11.9	155.5
> 0.75 to 0.92	0.55	7.12

FLATHEAD

Compactness Coefficient Class	% of LMU	Hectares
> 0 to 0.24	61.09	1291.188
> 0.24 to 0.41	27.56	582.5
> 0.41 to 0.58	7.88	166.5
> 0.58 to 0.75	3.2	67.562
> 0.75 to 0.92	0.28	6

HEAD WATER VALLEYS

Compactness Coefficient Class	% of LMU	Hectares
> 0 to 0.24	38.06	12,168.562
> 0.24 to 0.41	39.96	12,774.562
> 0.41 to 0.58	16.07	5138.625
> 0.58 to 0.75	4.75	1517.75
> 0.75 to 0.92	1.15	369

HILLCREST

Compactness Coefficient Class	% of LMU	Hectares
> 0 to 0.24	52.65	2143.875
> 0.24 to 0.41	40.95	1667.125
> 0.41 to 0.58	4.14	168.375
> 0.58 to 0.75	1.6	65.125
> 0.75 to 0.92	0.66	27.062

HORSESHOE PARKLAND

Compactness Coefficient Class	% of LMU	Hectares
> 0 to 0.24	29.05	5634.875
> 0.24 to 0.41	38.76	7518.375
> 0.41 to 0.58	24.13	4680.5
> 0.58 to 0.75	7.2	1395.625

IRONSTONE

Compactness Coefficient Class	% of LMU	Hectares
> 0 to 0.24	66.53	5401.5
> 0.24 to 0.41	19.49	1582.625
> 0.41 to 0.58	9.31	755.875
> 0.58 to 0.75	4.07	330.688
> 0.75 to 0.92	0.6	48.438

LIVINGSTONE VALLEY

Compactness Coefficient Class	% of LMU	Hectares
> 0 to 0.24	67.73	3908.25
> 0.24 to 0.41	21.04	1214.125
> 0.41 to 0.58	8.17	471.438
> 0.58 to 0.75	2.54	146.688
> 0.75 to 0.92	0.52	30.25

MIDDLE RIDGES

Compactness Coefficient Class	% of LMU	Hectares
> 0 to 0.24	65.75	41021.5
> 0.24 to 0.41	24.82	15,486.75
> 0.41 to 0.58	7.2	4492.688
> 0.58 to 0.75	1.97	1228.125
> 0.75 to 0.92	0.26	162.688

NORTH LIVINGSTONE

Compactness Coefficient Class	% of LMU	Hectares
> 0 to 0.24	56.74	15,228
> 0.24 to 0.41	31.01	8322.188
> 0.41 to 0.58	9.37	2515.75
> 0.58 to 0.75	2.69	722.5
> 0.75 to 0.92	0.18	49.5

PORCUPINE HILLS

Compactness Coefficient Class	% of LMU	Hectares
> 0 to 0.24	24.74	11,721.062
> 0.24 to 0.41	42.89	20,318.75
> 0.41 to 0.58	23.43	11,102
> 0.58 to 0.75	8.19	3880.625
> 0.75 to 0.92	0.74	352.312

SADDLE MOUNTAIN

Compactness Coefficient Class	% of LMU	Hectares
> 0 to 0.24	52.01	8657.812
> 0.24 to 0.41	28.06	4670.625
> 0.41 to 0.58	14.23	2369.688
> 0.58 to 0.75	5.23	870.75
> 0.75 to 0.92	0.47	79.062

SOUTH LIVINGSTONE

Compactness Coefficient Class	% of LMU	Hectares
> 0 to 0.24	54.98	2384.25
> 0.24 to 0.41	28.31	1227.562
> 0.41 to 0.58	14.45	626.688
> 0.58 to 0.75	2.26	98
	0.86	167.375

SOUTH FESCUE

Compactness Coefficient Class	% of LMU	Hectares
> 0 to 0.24	1	8.062
> 0.24 to 0.41	50.08	404.312
> 0.41 to 0.58	30.45	245.812
> 0.58 to 0.75	14.89	120.25
> 0.75 to 0.92	3.58	28.938

WHALEBACK

Compactness Coefficient Class	% of LMU	Hectares
> 0 to 0.24	33.5	8059
> 0.24 to 0.41	43.22	10,398.75
> 0.41 to 0.58	15.84	3810.188
> 0.58 to 0.75	6.85	1647.875
> 0.75 to 0.92	0.6	144.125

TABLE 7. cont'd CIRCULARITY OF DISTURBANCE PATCH BY REGION AND LMU

REGION (STUDY AREA)

Circularity Coefficient Class	% of LMU	Hectares
> 0 to 0.056	80.72	220,251.75
> 0.056 to 0.11	14.07	38,397.188
> 0.11 to 0.16	4.18	11,401.438
> 0.16 to 0.22	0.91	2495.938
> 0.22 to 0.27	0.11	298.75

ALPINE HIGH ROCK

Circularity Coefficient Class	% of LMU	Hectares
> 0 to 0.056	80.51	1529.312
> 0.056 to 0.11	12.42	235.875
> 0.11 to 0.16	5.25	99.812
> 0.16 to 0.22	1.82	34.5

BEAVER

Circularity Coefficient Class	% of LMU	Hectares
> 0 to 0.056	82.59	4608.188
> 0.056 to 0.11	13.21	737.25
> 0.11 to 0.16	3.51	195.688
> 0.16 to 0.22	0.57	31.938
> 0.22 to 0.27	0.12	6.688

CHAPEL ROCK

Circularity Coefficient Class	% of LMU	Hectares
> 0 to 0.056	68.31	3749.625
> 0.056 to 0.11	23.89	1311.312
> 0.11 to 0.16	6.74	369.75
> 0.16 to 0.22	1.06	58.438

CROWSNEST PASS

Circularity Coefficient Class	% of LMU	Hectares
> 0 to 0.056	85.67	4003.688
> 0.056 to 0.11	10.67	498.5
> 0.11 to 0.16	2.8	130.938
> 0.16 to 0.22	0.74	34.375
> 0.22 to 0.27	0.12	5.625

EAST RANCHLANDS

Circularity Coefficient Class	% of LMU	Hectares
> 0 to 0.056	63.09	824.438
> 0.056 to 0.11	25.63	334.938
> 0.11 to 0.16	10.39	135.812
> 0.16 to 0.22	0.89	11.625

FLATHEAD

Circularity Coefficient Class	% of LMU	Hectares
> 0 to 0.056	88.64	1873.688
> 0.056 to 0.11	8	169.125
> 0.11 to 0.16	2.86	60.5
> 0.16 to 0.22	0.31	6.5
> 0.22 to 0.27	0.19	3.938

HEAD WATER VALLEYS

Circularity Coefficient Class	% of LMU	Hectares
> 0 to 0.056	79.12	25,293.375
> 0.056 to 0.11	15.11	4831.938
> 0.11 to 0.16	3.61	1154.875
> 0.16 to 0.22	1.86	593.625
> 0.22 to 0.27	0.3	94.688

HILLCREST

Circularity Coefficient Class	% of LMU	Hectares
> 0 to 0.056	93.6	3811
> 0.056 to 0.11	4.14	168.375
> 0.11 to 0.16	1.6	65.125
> 0.16 to 0.22	0.57	23.312
> 0.22 to 0.27	0.09	3.75

HORSESHOE PARKLAND

Circularity Coefficient Class	% of LMU	Hectares
> 0 to 0.056	69.36	13,452.938
> 0.056 to 0.11	22.7	4402.875
> 0.11 to 0.16	6.44	1248.875
> 0.16 to 0.22	1.46	283.062
> 0.22 to 0.27	0.05	9

IRONSTONE

Circularity Coefficient Class	% of LMU	Hectares
> 0 to 0.056	86.02	6984.125
> 0.056 to 0.11	9.31	755.875
> 0.11 to 0.16	4	324.625
> 0.16 to 0.22	0.57	45.875
> 0.22 to 0.27	0.11	8.625

LIVINGSTONE VALLEY

Circularity Coefficient Class	% of LMU	Hectares
> 0 to 0.056	89.96	5191.625
> 0.056 to 0.11	7.11	410.062
> 0.11 to 0.16	1.81	104.5
> 0.16 to 0.22	0.91	52.625
> 0.22 to 0.27	0.21	11.938

MIDDLE RIDGES

Circularity Coefficient Class	% of LMU	Hectares
> 0 to 0.056	90.95	56,748.125
> 0.056 to 0.11	6.83	4262.5
> 0.11 to 0.16	1.79	1116.5
> 0.16 to 0.22	0.36	226.062
> 0.22 to 0.27	0.06	38.562

NORTH LIVINGSTONE

Circularity Coefficient Class	% of LMU	Hectares
> 0 to 0.056	88.1	23,645.438
> 0.056 to 0.11	9.18	2465.062
> 0.11 to 0.16	2.28	611.125
> 0.16 to 0.22	0.41	109.562
> 0.22 to 0.27	0.03	6.75

PORCUPINE HILLS

Circularity Coefficient Class	% of LMU	Hectares
> 0 to 0.056	68.69	32,543.875
> 0.056 to 0.11	22.92	10,860.438
> 0.11 to 0.16	7.05	3340
> 0.16 to 0.22	1.21	574.75
> 0.22 to 0.27	0.12	55.688

SADDLE MOUNTAIN

Circularity Coefficient Class	% of LMU	Hectares
> 0 to 0.056	80.42	13,388.062
> 0.056 to 0.11	14.15	2356.5
> 0.11 to 0.16	4.51	750.75
> 0.16 to 0.22	0.81	135.125
> 0.22 to 0.27	0.11	17.5

SOUTH FESCUE

Circularity Coefficient Class	% of LMU	Hectares
> 0 to 0.056	51.08	412.375
> 0.056 to 0.11	33.84	273.25
> 0.11 to 0.16	10.07	81.312
> 0.16 to 0.22	3.27	26.375
> 0.22 to 0.27	1.74	14.062

SOUTH LIVINGSTONE

Circularity Coefficient Class	% of LMU	Hectares
> 0 to 0.056	83.74	3631.188
> 0.056 to 0.11	14	607.312
> 0.11 to 0.16	1.98	86
> 0.16 to 0.22	0.28	12

WHALEBACK

Circularity Coefficient Class	% of LMU	Hectares
> 0 to 0.056	77.14	18,560.562
> 0.056 to 0.11	15.44	3716
> 0.11 to 0.16	6.34	1525.25
> 0.16 to 0.22	0.98	236.188
> 0.22 to 0.27	0.09	21.938

The higher the value, the more compact the shape of the patch.

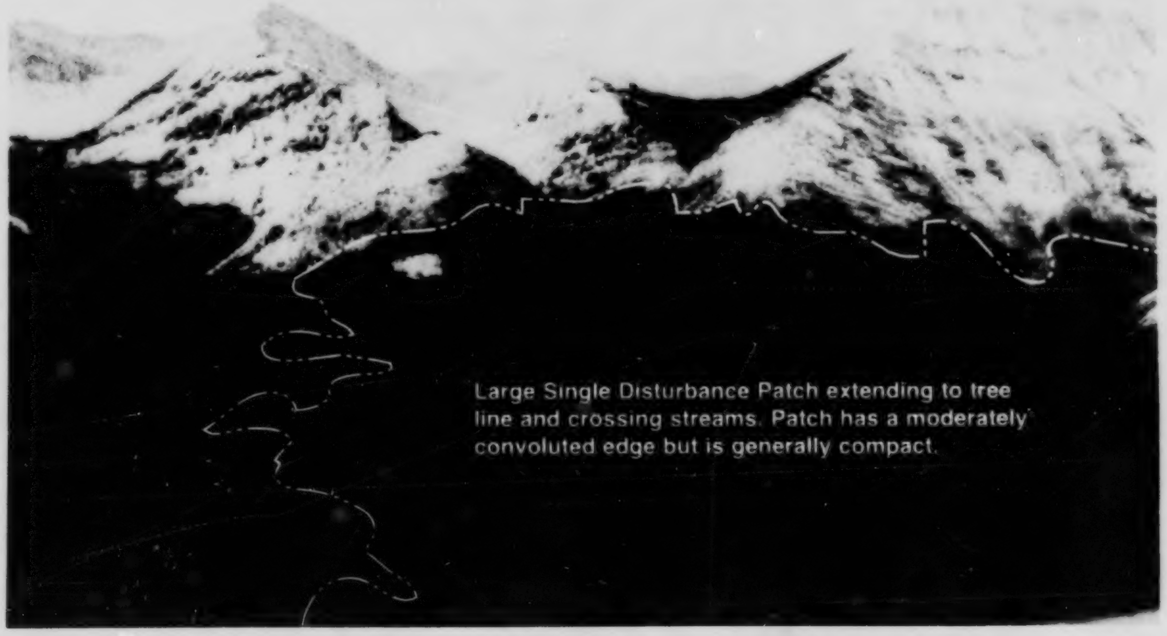
Circularity (C_2) was also calculated based upon the formula

$$C_2 = \frac{4A}{P^2}$$

where: A = area and p = perimeter

Mean	**0.09**
Minimum	**0.002**
Maximum	**0.50**
Standard deviation	**0.06**

The higher the value, the more circular the shape of the patch. As patch shape is somewhat dependent upon the mapping scale, the finest level of detail available for patch boundaries was utilized. Circularity and compactness were also calculated for the landscape management units in addition to the regional analysis. There are variations between LMUs. The major differences correlate with changes in natural sub region with fescue grasslands, parklands, montane and subalpine exhibiting a range of compactness from highest to lowest, respectively. The most convoluted shapes are found in the subalpine. In general, shapes are not very compact or circular in any of the LMUs. Should rectilinear cutting continue in the area, patch shape can be expected to be significantly altered. While shape has not been specifically correlated with ecological attributes in the area (and is unlikely to be in the near future), it would be prudent to retain the general shape characteristics found in the area and avoid cutting in rectilinear blocks or blocks with little curvilinearity (lobes and coves).



Large Single Disturbance Patch extending to tree line and crossing streams. Patch has a moderately convoluted edge but is generally compact.

2.1.2 LANDSCAPE SCALE EVALUATION OF DISTURBANCE BY FIRE

While regional scale analysis of disturbance characteristics is valuable, analysis at the scale of landscapes or landscape management units (LMUs) is also required. Individual landscapes have differing disturbance characteristics which must be recognized and characterized to ensure that disturbance management is responsive to the differing conditions. While disturbance flows, such as fires, cross landscape boundaries, they result in differing age class distributions and disturbance patch size distributions from landscape to landscape primarily due to topography, climate and vegetation. These variables must be examined at a finer scale in order to accurately inform prescriptions and design criteria for individual landscapes or LMUs. The following is the landscape scale disturbance analyses.

2.1.2.1 AGE CLASS DISTRIBUTION BY LANDSCAPE

The following charts indicate the age class distribution in the various landscape management units. There is a high degree of variability between the LMUs. The most complete representation of age classes is found in the Head Water Valleys which escaped the last major disturbances at the beginning of the century. This is also the area of greatest amount of logging. The following is a brief overview of the age class charts.

Alpine High Rock — The alpine high rock landscape does contain some forest tree cover. Age class distribution indicates the representation of a broad number of age classes with a preponderance of the origin classes in the 1930s. It is diverse in terms of age class and includes almost all classes found in the region.

Beaver — This LMU has a limited age class diversity with over 35% of the area in a single decade (1920 to 1929). The area is adjacent to the Crowsnest Pass and human caused fires were common in this area.

Chapel Rock has a similarly low age class diversity and also has a high proportion in the 1920 to 1929 class.

Crowsnest Pass has a limited range of classes which is distributed mainly in the 1880 to 1939 range. This heavily settled area was also subject to many human caused fires.

East Ranchlands has very little tree cover and no one class exceeds 0.7% of the LMU. Again, age class is limited.

Head Water Valleys has the highest age class diversity of any landscape in the study area. This is due to the fact that the area escaped many of the fires at the turn of the century. Cutting in the area has had a pronounced effect on the age class distribution, although no single class is currently close to elimination. Stands with origins older than 1700 are rare in the region, but have had a relatively large proportion of the class removed through logging. As mentioned previously, when the change in age class distribution due to logging is examined at the regional level, it appears to have had very little effect. However, at the landscape level, the changes are much more pronounced.

Hillcrest also has been heavily disturbed in this century. Most of the stands have origins in this century or in the late 1800s. Hillcrest is adjacent to heavily settled areas and human influence has been high.

Horseshoe Parklands has a preponderance of age classes originating at the turn of the century. It also has a very small amount of very old forest dating to 1790.

Ironstone — The years of origin 1890 to 1939 make up almost all the forested area of the LMU with some amounts of very old growth. Cutting in the area has been focused on the 1890 to 1899 origin class.

Livingstone Valley — This LMU has a very diverse age class distribution, but the majority of the area is made up of the classes 1870 to 1879 and 1910 to 1919. Cutting in the area has concentrated on the origin class 1870 to 1879.

Middle Ridges — This landscape has a diverse class distribution, but almost all the landscape is in the classes from 1860 to 1940. Very little logging has been carried out on the area. This landscape shows a very regular amount (with the exception of a pulse in the 1910 to 1919 class) of area of age classes which may be useful for even flow sequencing in the area.

Porcupine Hills — This landscape has a diverse class distribution, as well as a large proportion of the area in the classes 1870 to 1950. Very little logging has been carried out on the area, despite the amount of mature timber.

Saddle Mountain is limited in terms of age class diversity with over 30% in the 1910 to 1919 class.

South Fescue has very little tree cover and a limited amount of age class diversity.

The landscape mosaic of the Saddle Mountain LMU. Age class representation is limited. Biodiversity on the other hand is extremely high. Grassland with deciduous and mixedwood forest, together with occasional wetlands, offers a high degree of interspersion of habitats.

South Livingstone demonstrates peaks in the 1880 to 1890 class as well as in 1930 to 1939. Little of the unit can be considered mature.

Whaleback — Much of the landscape is of the 1910 to 1919 class. About 14% of the LMU is at maturity. There is a relatively diverse range of age classes.

Flathead — Most of this landscape is in the 1930 to 1939 class. Contains only 9 of the 40 age classes present in the region.

The number of different age classes found in each of the landscape management units is presented in the following table. The Head Water Valleys and the Middle Ridges have the greatest diversity of age classes, while many other landscapes have very little.

TABLE 8. NUMBER OF AGE CLASSES REPRESENTED IN LANDSCAPE MANAGEMENT UNITS

# of Age Classes	Landscape Management Unit
34	Head Water Valleys
32	Middle Ridges
28	Alpine High Rock
22	North Livingstone
20	Livingstone Valley
18	Porcupine Hills
16	Whaleback
14	Ironstone
13	Horseshoe Parkland
12	Crowsnest Pass
12	South Livingstone
12	Beaver
12	Saddle Mountain
12	Chapel Rock
10	Hillcrest
10	East Ranchlands
9	Flathead
9	South Fescue

2.1.2.2 EVALUATION OF DISTURBANCE PATCH SIZE BY LANDSCAPE

The following tables and charts indicate the disturbance patch size distribution for the landscapes in the study area. These distributions will be useful in setting design characteristics for the landscapes or, at the very least, comparing the divergence or coincidence of alternatives from the current situation. Landscapes clearly differ in the distribution of the size of disturbance events (e.g., almost half of the forested area of the Middle Ridges was the result of events over 1000 ha while in the Porcupine Hills the disturbance regime resulted in much smaller patches — approximately 75% of the area in patches less than 250 ha and 32% in patches less than 50 ha). The following charts indicate the percentage of the forested area of the Landscape Management Unit that falls in the various size classes. The size classes are the same as those used in the regional analysis. Note that

FIGURE 7. ALPINE HIGH ROCK LMU AGE CLASS DISTRIBUTION CURRENT AND INFERRED

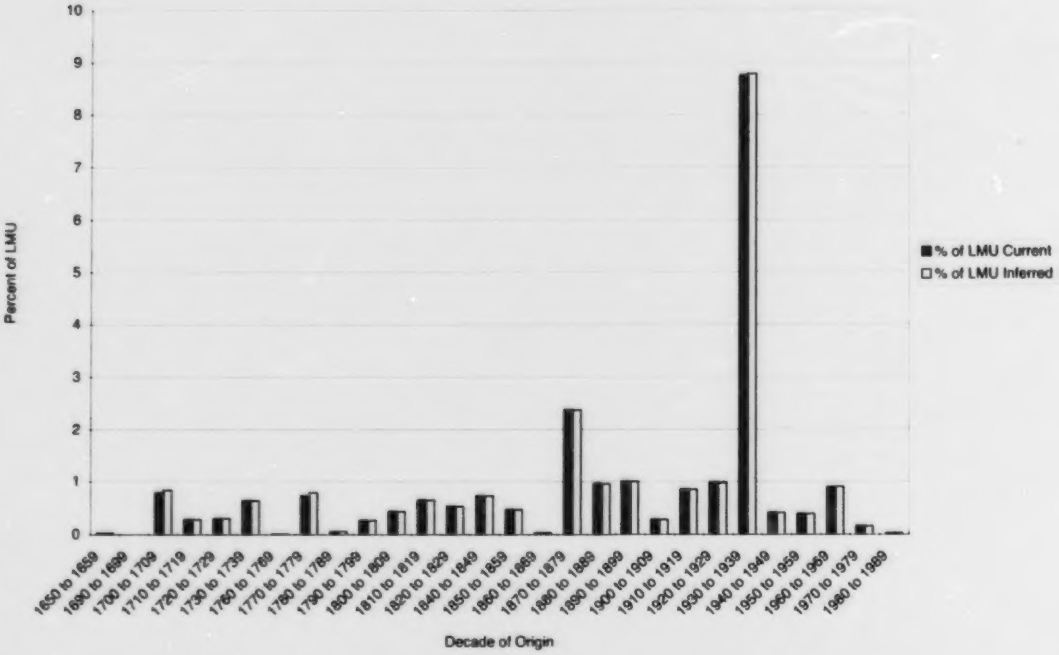


FIGURE 8. BEAVER LMU AGE CLASS DISTRIBUTION CURRENT AND INFERRED

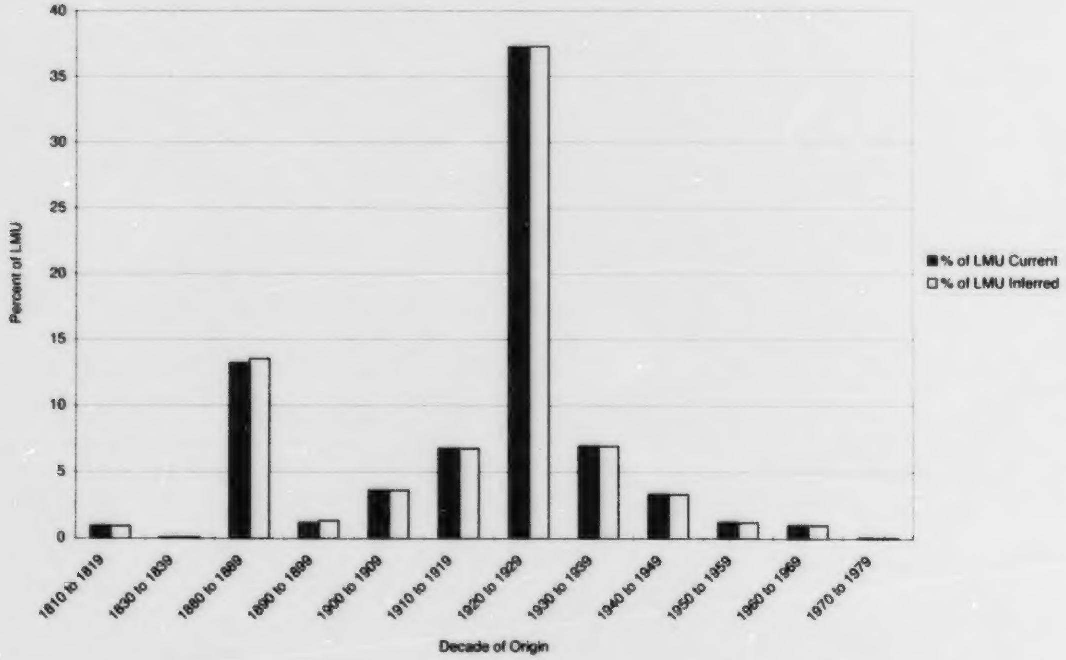


FIGURE 9. CHAPEL ROCK LMU AGE CLASS DISTRIBUTION CURRENT AND INFERRED

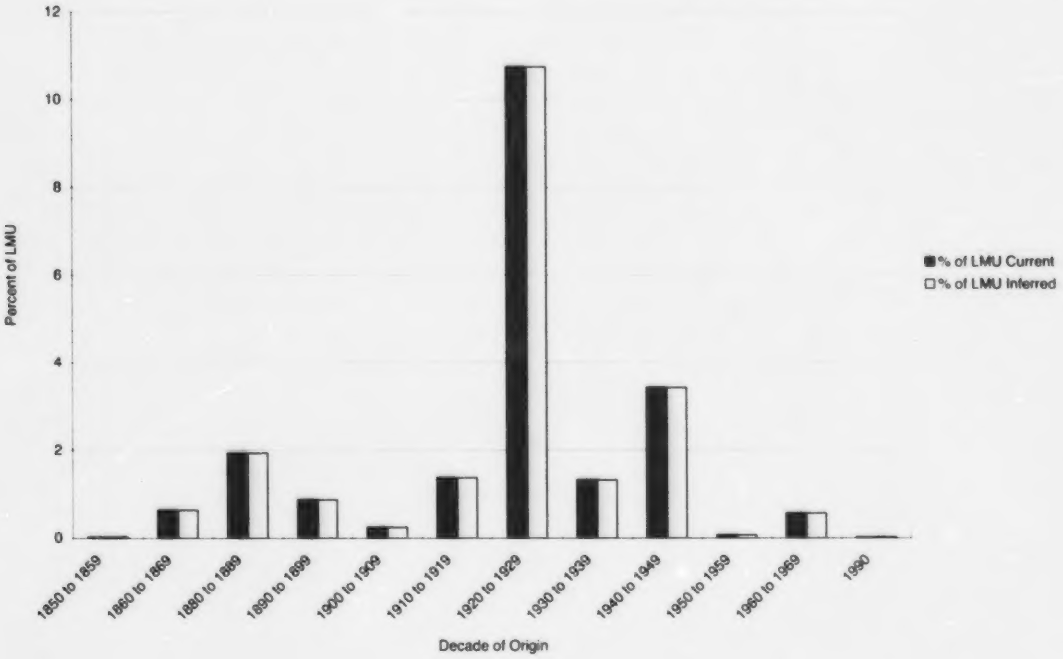


FIGURE 10. CROWSNEST PASS LMU AGE CLASS DISTRIBUTION CURRENT AND INFERRED

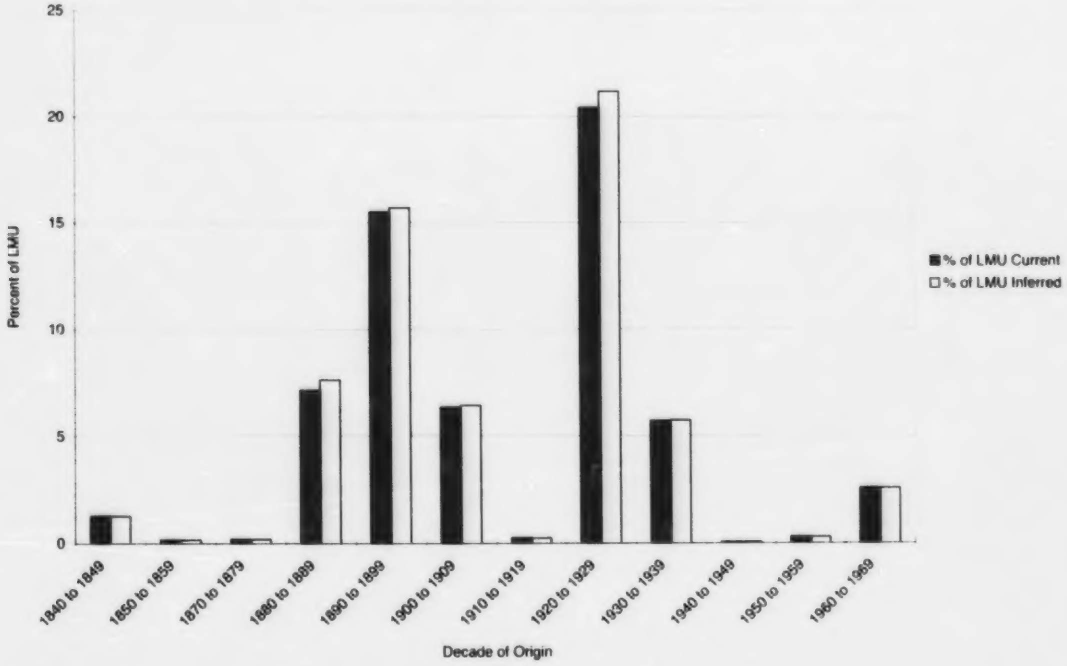


FIGURE 11. EAST RANCHLANDS LMU AGE CLASS DISTRIBUTION CURRENT AND INFERRED

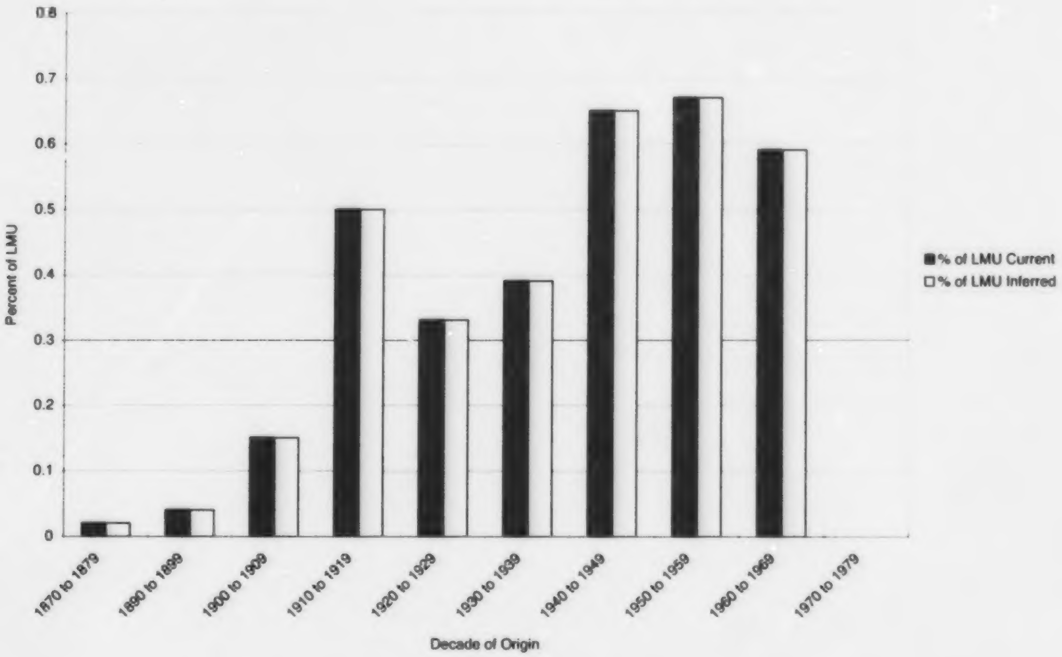


FIGURE 12. HEAD WATER VALLEYS LMU AGE CLASS DISTRIBUTION CURRENT AND INFERRED

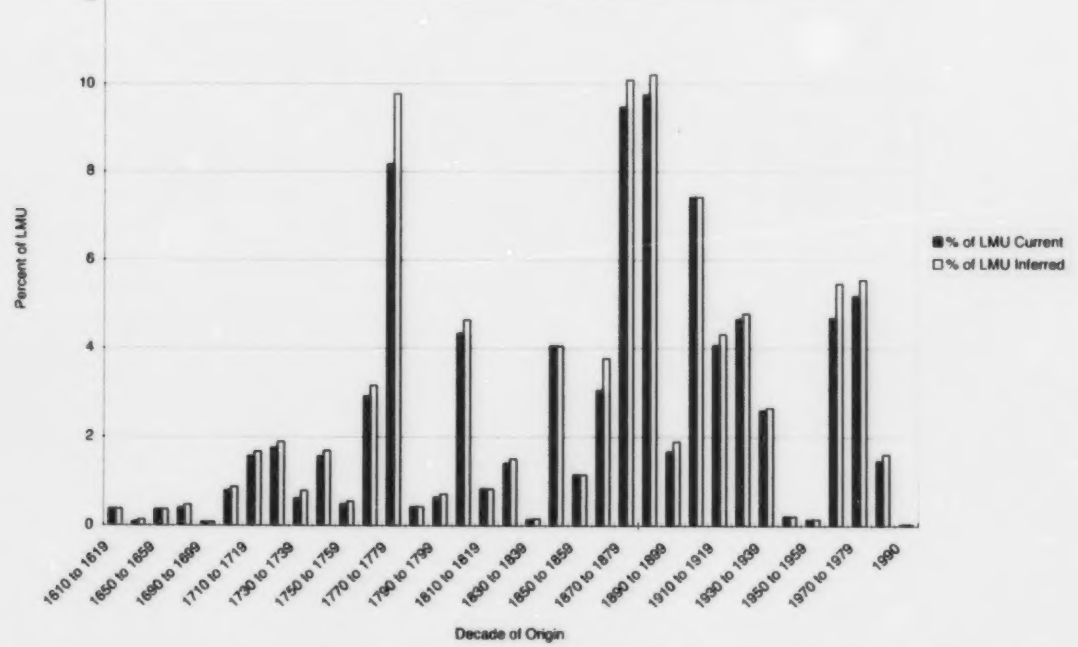


FIGURE 13. HILLCREST LMU AGE CLASS DISTRIBUTION CURRENT AND INFERRED

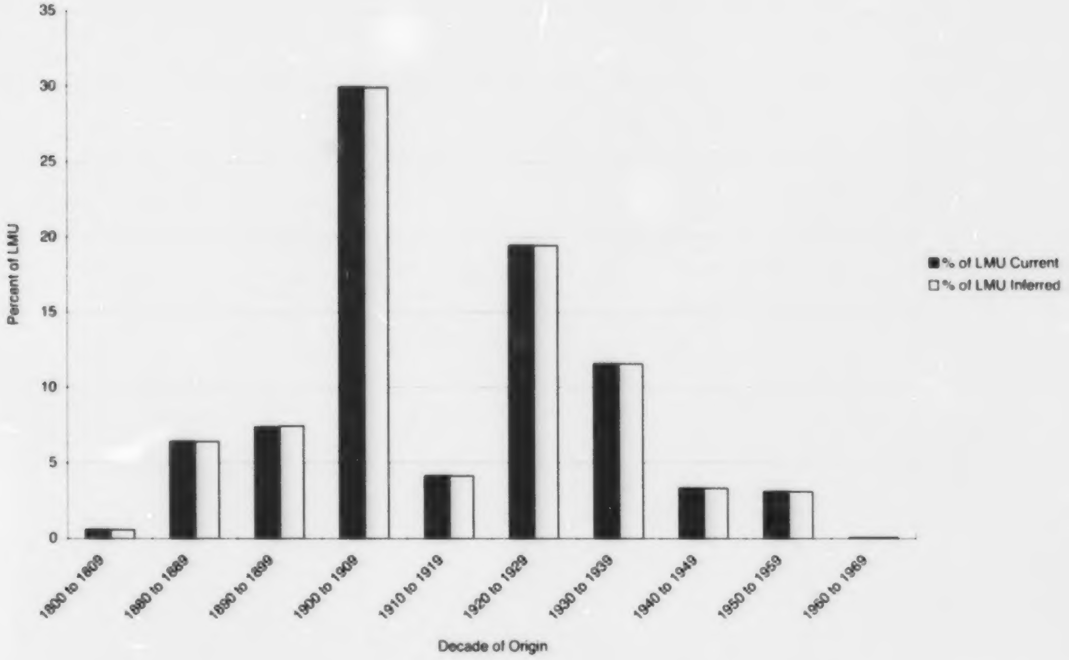


FIGURE 14. HORSESHOE PARKLAND LMU AGE CLASS DISTRIBUTION CURRENT AND INFERRED

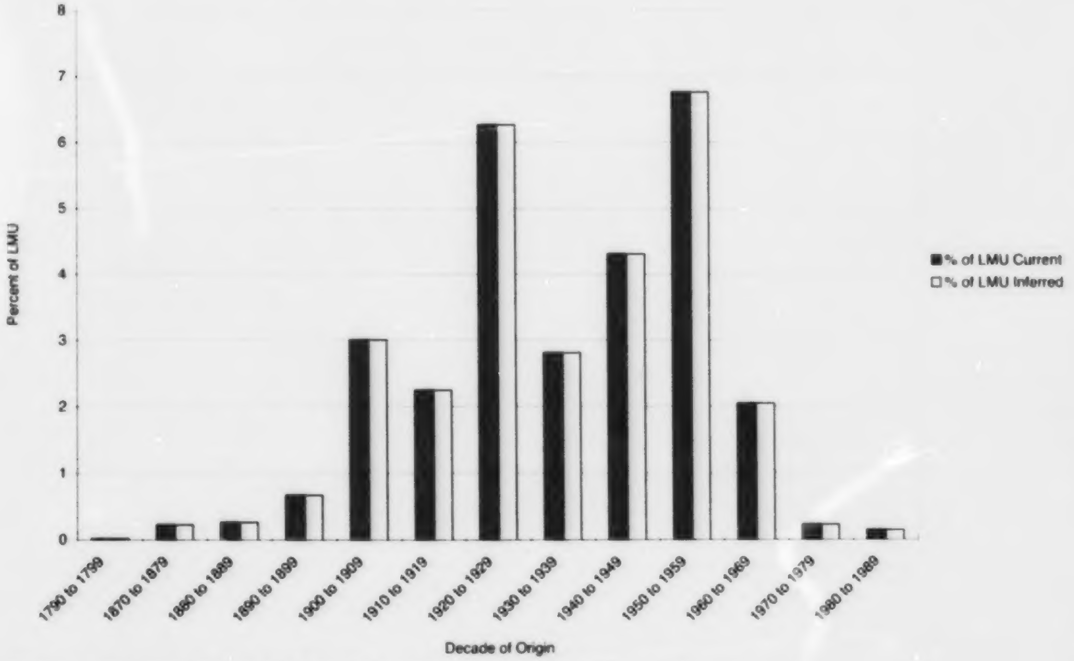


FIGURE 15. IRONSTONE LMU AGE CLASS DISTRIBUTION CURRENT AND INFERRED

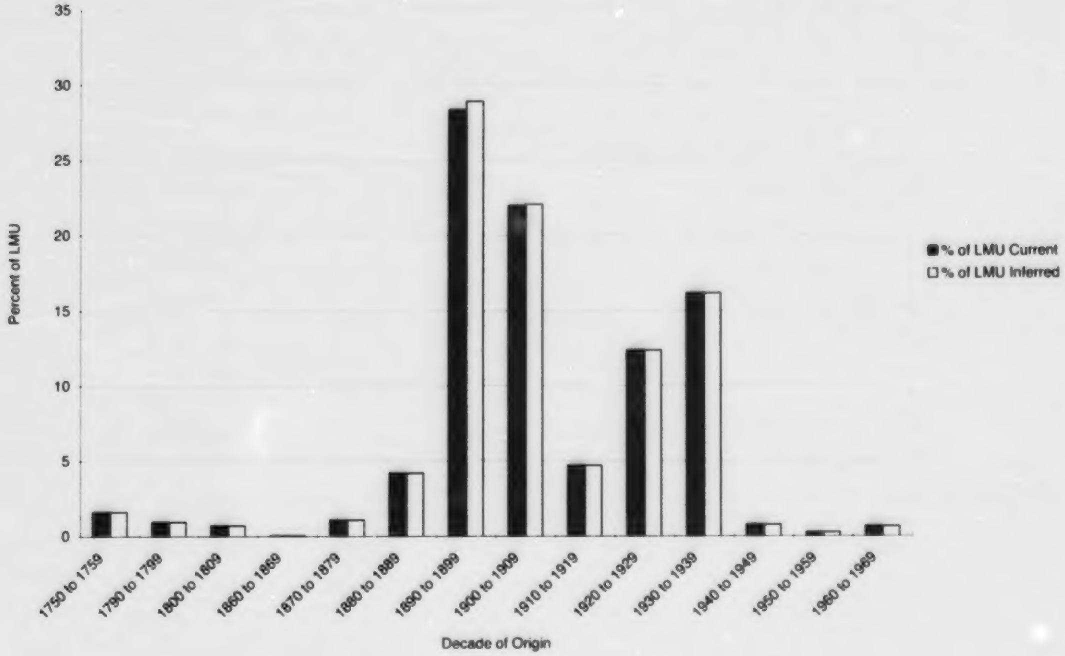


FIGURE 16. LIVINGSTONE VALLEY LMU AGE CLASS DISTRIBUTION CURRENT AND INFERRED

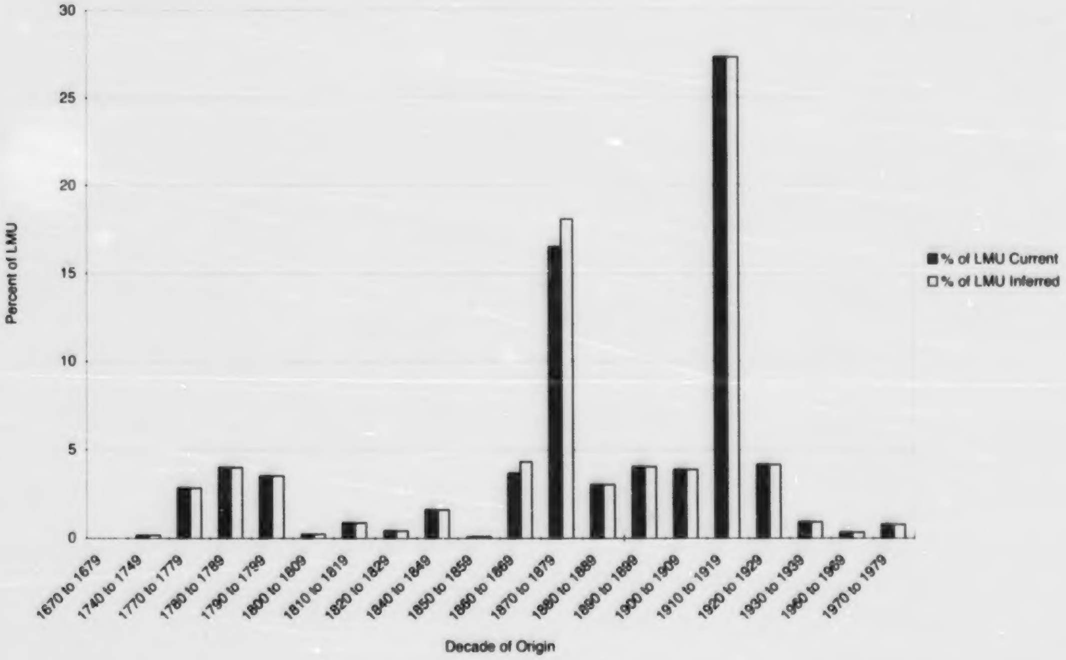


FIGURE 17. MIDDLE RIDGES LMU AGE CLASS DISTRIBUTION
CURRENT AND INFERRED

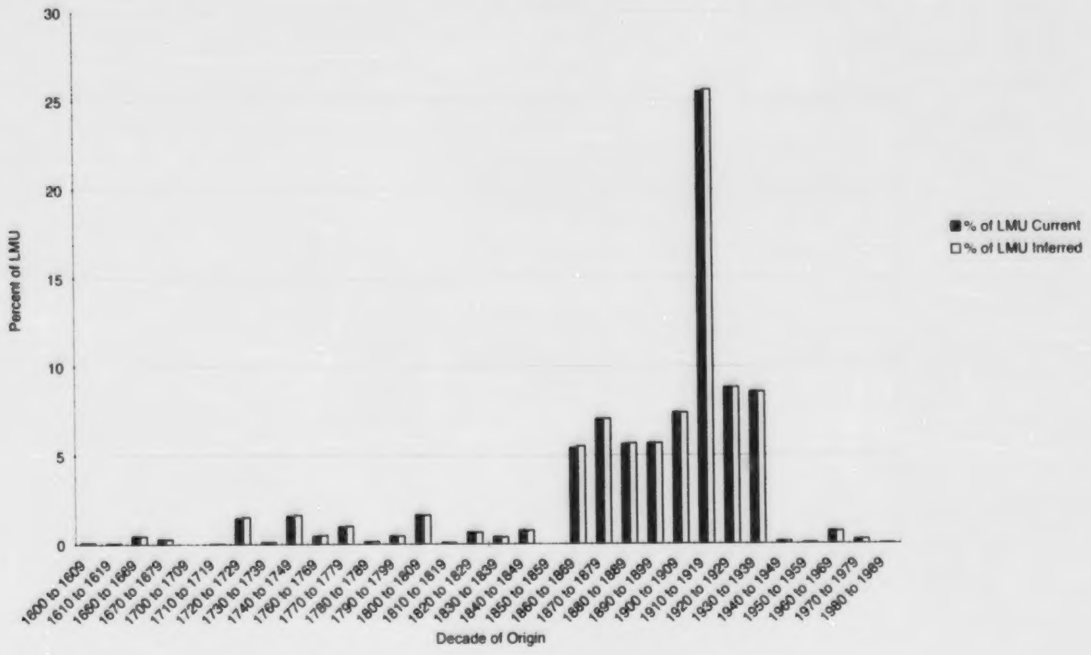


FIGURE 18. PORCUPINE LMU AGE CLASS DISTRIBUTION
CURRENT AND INFERRED

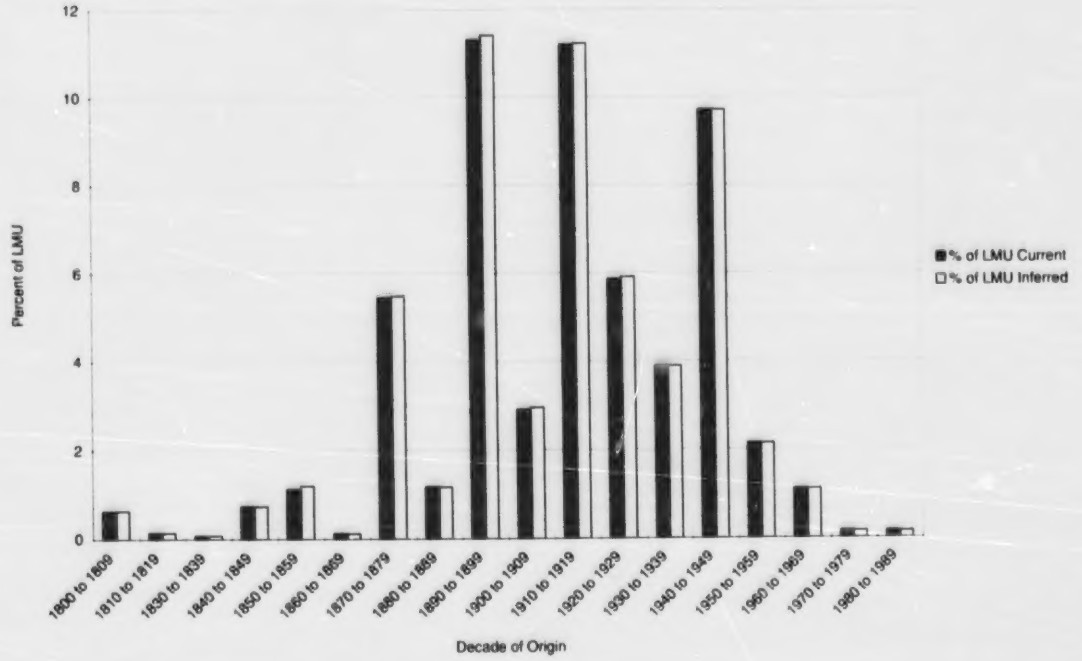


FIGURE 19. SADDLE MOUNTAIN LMU AGE CLASS DISTRIBUTION CURRENT AND INFERRED

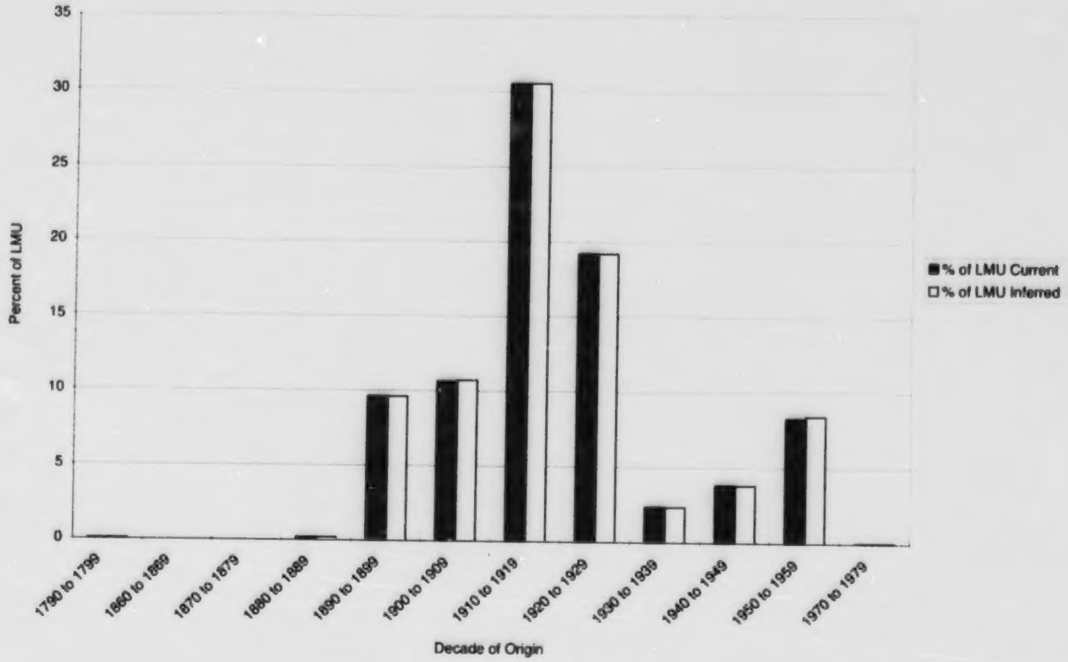


FIGURE 20. SOUTH FESCUE LMU AGE CLASS DISTRIBUTION CURRENT AND INFERRED

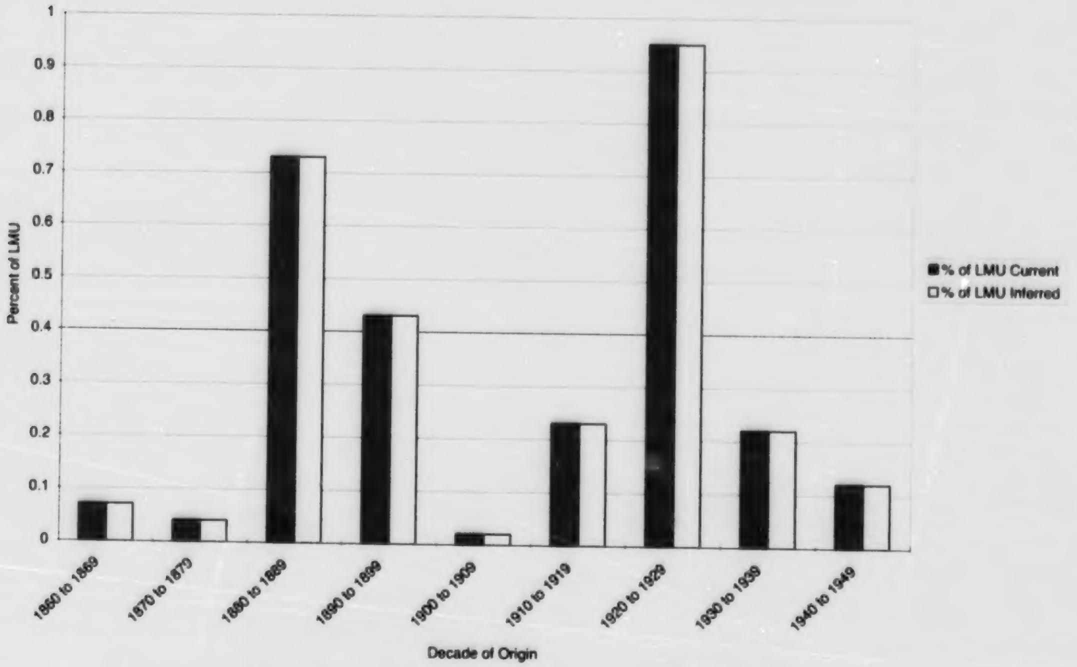


FIGURE 21. SOUTH LIVINGSTONE LMU AGE CLASS DISTRIBUTION CURRENT AND INFERRED

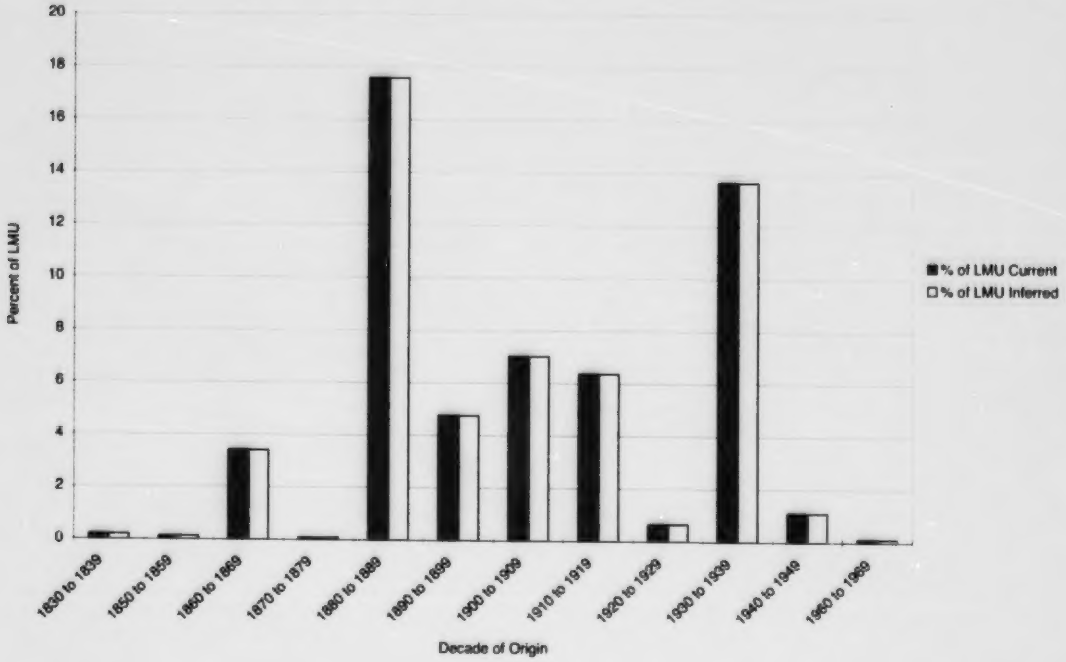


FIGURE 22. WHALEBACK LMU AGE CLASS DISTRIBUTION CURRENT AND INFERRED

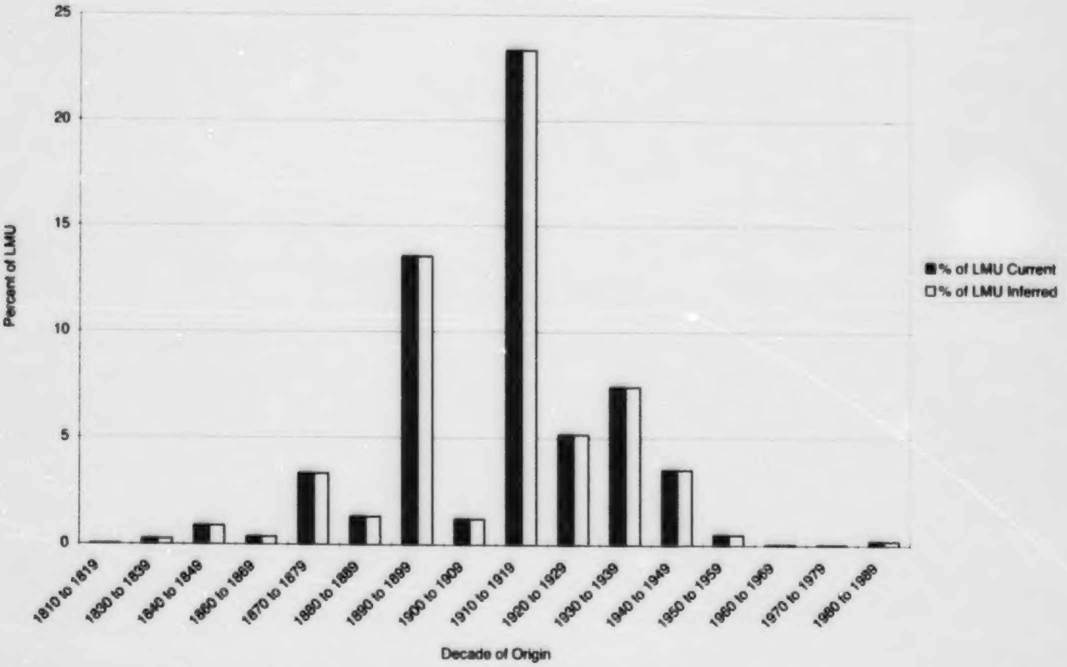


FIGURE 23. FLATHEAD LMU AGE CLASS DISTRIBUTION CURRENT AND INFERRED

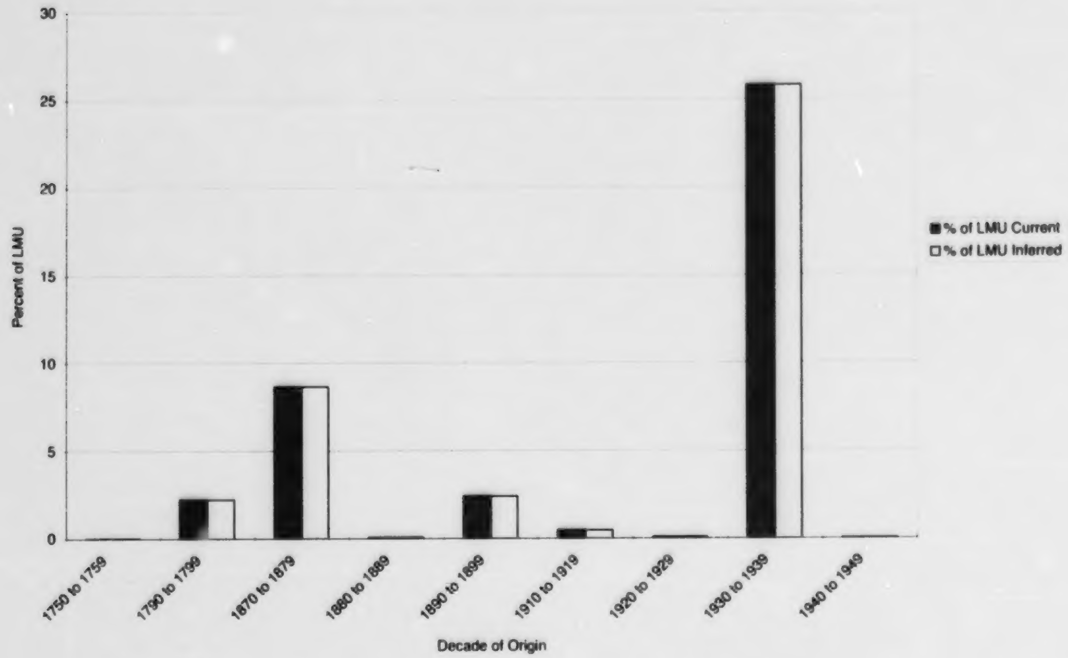
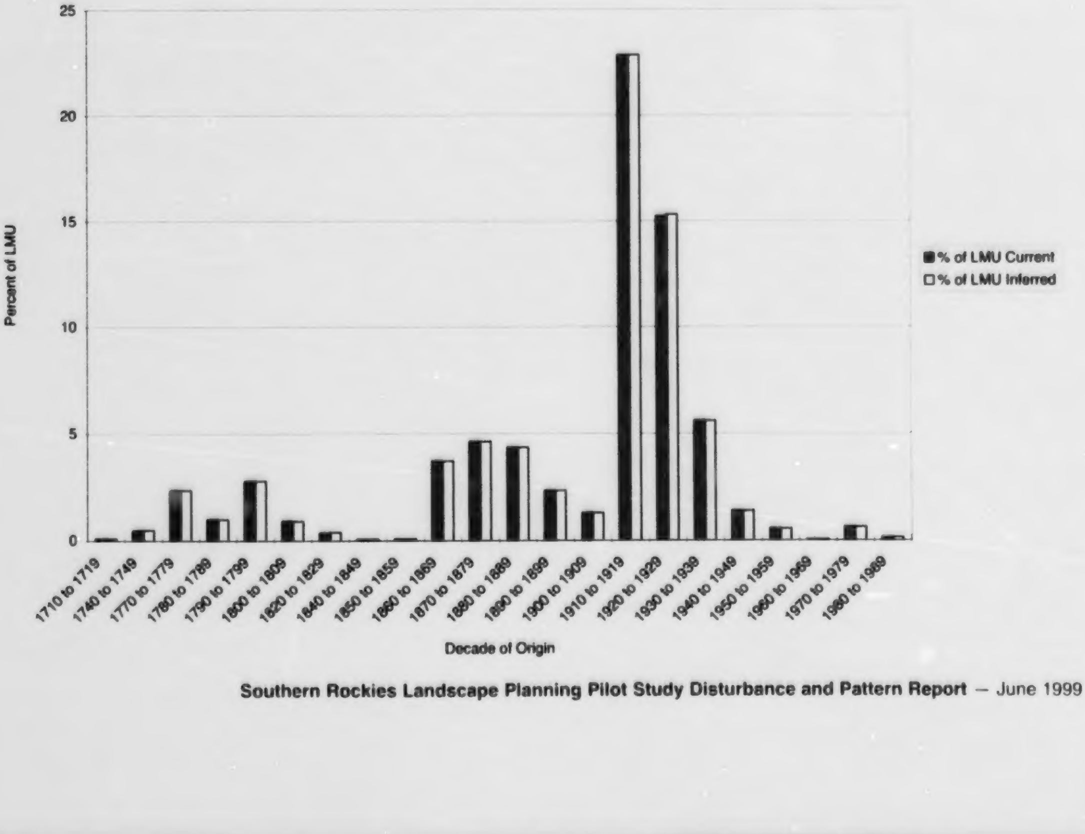
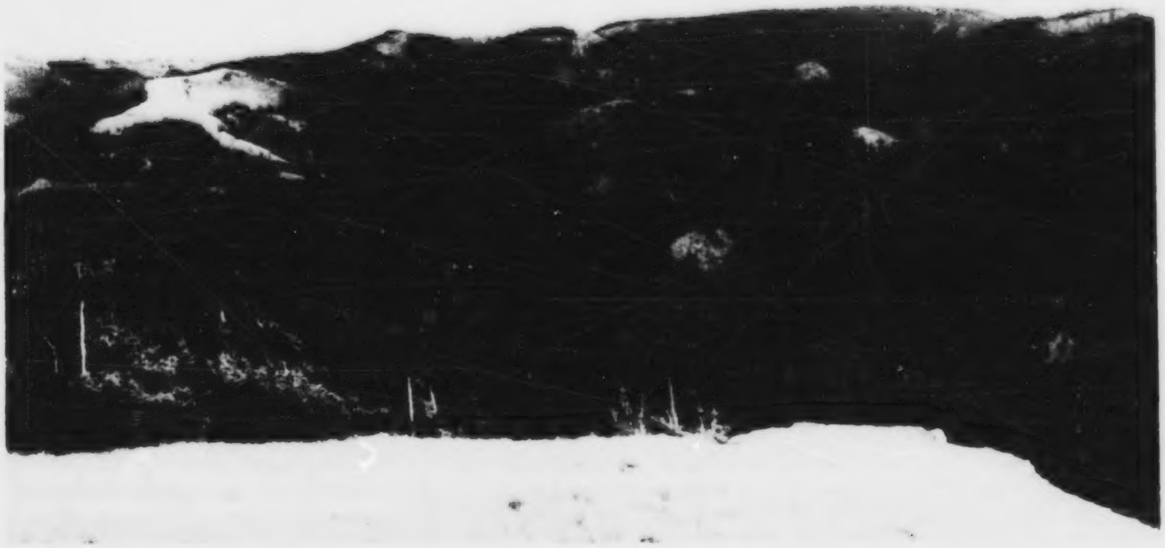


FIGURE 24. NORTH LIVINGSTONE LMU AGE CLASS DISTRIBUTION CURRENT AND INFERRED



disturbance patches may cross LMU boundaries.



The control of non lethal forces in the Porcupine Hills is causing [illegible] encroachment that may [illegible] normally fire resistant [illegible]

TABLE 9. DISTURBANCE PATCH SIZE CLASS DISTRIBUTIONS FOR LANDSCAPE MANAGEMENT UNITS

Regional	% of forest	area (ha)
>2 ha	0.25	678.44
>2 and <=10 ha	5.26	14,364.69
>10 and <=50 ha	21.71	59,289.13
>50 and <=250 ha	27.95	76,334.31
>250 and <=500 ha	11.56	31,571.69
>500 and <=1000 ha	10.57	28,859.25
>1000 ha and <=5000 ha	18.03	49,252.69
>5000 ha and <=10,000 ha	0.00	0.00
>10,000 ha	4.68	12,777.00

Middle Ridges	% of forest	area (ha)
>2 ha	0.16	101.50
>2 and <=10 ha	2.91	1813.75
>10 and <=50 ha	10.31	6434.38
>50 and <=250 ha	16.49	10,294.00
>250 and <=500 ha	7.51	4685.69
>500 and <=1000 ha	14.16	8841.25
>1000 ha and <=5000 ha	37.66	23,505.69
>5000 ha and <=10,000 ha	0	0.00
>10,000 ha	10.8	6742.69

Alpine High Rock	% of forest	area (ha)
>2 ha	1.85	35.44
>2 and <=10 ha	14.59	279.19
>10 and <=50 ha	22.84	437.13
>50 and <=250 ha	12.39	237.19
>250 and <=500 ha	31.86	609.75
>500 and <=1000 ha	1.1	21.13
>1000 ha and <=5000 ha	15.36	294.00
>5000 ha and <=10,000 ha	0	
>10,000 ha	0	

Ironstone	% of forest	area (ha)
>2 ha	0.12	9.56
>2 and <=10 ha	3.13	254.25
>10 and <=50 ha	10.51	853.00
>50 and <=250 ha	13.05	1059.19
>250 and <=500 ha	5.28	428.81
>500 and <=1000 ha	6.95	564.50
>1000 ha and <=5000 ha	60.96	4949.81
>5000 ha and <=10,000 ha	0	0.00
>10,000 ha	0	0.00

Head Water Valleys	% of forest	area (ha)
>2 ha	0.27	85.56
>2 and <=10 ha	3.48	1113.63
>10 and <=50 ha	12.37	3955.50
>50 and <=250 ha	22.57	7217.56
>250 and <=500 ha	16.58	5301.81
>500 and <=1000 ha	9.84	3146.94
>1000 ha and <=5000 ha	34.76	11,115.88
>5000 ha and <=10,000 ha	0	0.00
>10,000 ha	0.14	44.13

Hillcrest	% of forest	area (ha)
>2 ha	0.15	6.06
>2 and <=10 ha	2.2	89.69
>10 and <=50 ha	13.34	543.31
>50 and <=250 ha	17.84	726.44
>250 and <=500 ha	7.64	311.06
>500 and <=1000 ha	24.68	1004.75
>1000 ha and <=5000 ha	34.15	1390.25
>5000 ha and <=10,000 ha	0	0.00
>10,000 ha	0	0.00

Flathead	% of forest	area (ha)
>2 ha	0.48	10.25
>2 and <=10 ha	7.25	153.88
>10 and <=50 ha	11.68	248.00
>50 and <=250 ha	10.78	228.75
>250 and <=500 ha	13.18	279.69
>500 and <=1000 ha	20.08	426.25
>1000 ha and <=5000 ha	36.55	775.94
>5000 ha and <=10,000 ha	0	0.00
>10,000 ha	0	0.00

North Livingstone	% of forest	area (ha)
>2 ha	0.45	120.75
>2 and <=10 ha	5.24	1408.63
>10 and <=50 ha	16.06	4317.69
>50 and <=250 ha	27.66	7438.38
>250 and <=500 ha	14.93	4016.06
>500 and <=1000 ha	9.28	2496.38
>1000 ha and <=5000 ha	15.49	4164.75
>5000 ha and <=10,000 ha	0	0.00
>10,000 ha	10.89	2928.75

Crowsnest Pass	% of forest	area (ha)
>2 ha	0.09	4.13
>2 and <=10 ha	4.93	230.63
>10 and <=50 ha	18.47	863.94
>50 and <=250 ha	33.24	1554.75
>250 and <=500 ha	10.03	469.19
>500 and <=1000 ha	12.76	596.94
>1000 ha and <=5000 ha	20.47	957.44
>5000 ha and <=10,000 ha	0	0.00
>10,000 ha	0	0.00

Livingstone Valley	% of forest	area (ha)
>2 ha	0.22	12.44
>2 and <=10 ha	4.89	282.56
>10 and <=50 ha	10.43	602.25
>50 and <=250 ha	23.42	1352.38
>250 and <=500 ha	17.09	987.13
>500 and <=1000 ha	5.17	298.63
>1000 ha and <=5000 ha	17.92	1035.13
>5000 ha and <=10,000 ha	0	0.00
>10,000 ha	20.86	1204.38

South Livingstone	**% of forest**	**area (ha)**
>2 ha	0.02	0.88
>2 and <=10 ha	2.75	119.31
>10 and <=50 ha	18.68	810.00
>50 and <=250 ha	26.16	1134.69
>250 and <=500 ha	19.01	824.50
>500 and <=1000 ha	8.37	362.81
>1000 ha and <=5000 ha	25.01	1084.88
>5000 ha and <=10,000 ha	0	0.00
>10,000 ha	0	0.00

Beaver	**% of forest**	**area (ha)**
>2 ha	0.31	17.31
>2 and <=10 ha	2.99	167.13
>10 and <=50 ha	21.25	1187.63
>50 and <=250 ha	26.89	1502.63
>250 and <=500 ha	10.81	604.31
>500 and <=1000 ha	9.14	510.75
>1000 ha and <=5000 ha	28.6	1598.25
>5000 ha and <=10,000 ha	0	0.00
>10,000 ha	0	0.00

Horse Shoe Parkland	**% of forest**	**area (ha)**
>2 ha	0.27	52.25
>2 and <=10 ha	7.93	1540.44
>10 and <=50 ha	39.84	7738.00
>50 and <=250 ha	36.14	7019.13
>250 and <=500 ha	6.68	1297.94
>500 and <=1000 ha	6.91	1342.69
>1000 ha and <=5000 ha	2.23	432.81
>5000 ha and <=10,000 ha	0	0.00
>10,000 ha	0	0.00

Saddle Mountain	**% of forest**	**area (ha)**
>2 ha	0.38	62.69
>2 and <=10 ha	6.59	1097.94
>10 and <=50 ha	25.59	4262.19
>50 and <=250 ha	27.33	4551.63
>250 and <=500 ha	10	1666.38
>500 and <=1000 ha	6.97	1161.38
>1000 ha and <=5000 ha	23.14	3854.25
>5000 ha and <=10,000 ha	0	0.00
>10,000 ha	0	0.00

Whaleback	**% of forest**	**area (ha)**
>2 ha	0.09	22.69
>2 and <=10 ha	6.52	1569.63
>10 and <=50 ha	30.49	7340.19
>50 and <=250 ha	32.57	7839.44
>250 and <=500 ha	15.51	3734.13
>500 and <=1000 ha	6.85	1649.69
>1000 ha and <=5000 ha	0.24	58.06
>5000 ha and <=10,000 ha	0	0.00
>10,000 ha	7.71	1857.06

Chapel Rock	**% of forest**	**area (ha)**
>2 ha	0.84	46.44
>2 and <=10 ha	15.71	868.38
>10 and <=50 ha	39.99	2210.88
>50 and <=250 ha	40.67	2248.38
>250 and <=500 ha	1.35	74.88
>500 and <=1000 ha	0	0.00
>1000 ha and <=5000 ha	1.44	79.44
>5000 ha and <=10,000 ha	0	0.00
>10,000 ha	0	0.00

South Fescue	**% of forest**	**area (ha)**
>2 ha	1.14	9.38
>2 and <=10 ha	28.14	231.13
>10 and <=50 ha	53.7	441.00
>50 and <=250 ha	12.15	99.81
>250 and <=500 ha	4.86	39.94
>500 and <=1000 ha	0	0.00
>1000 ha and <=5000 ha	0	0.00
>5000 ha and <=10,000 ha	0	0.00
>10,000 ha	0	0.00

Porcupine Hills	**% of forest**	**area (ha)**
>2 ha	0.11	53.06
>2 and <=10 ha	5.75	2726.19
>10 and <=50 ha	32.33	15,325.63
>50 and <=250 ha	39.6	18,768.81
>250 and <=500 ha	8.54	4048.94
>500 and <=1000 ha	11.5	5449.50
>1000 ha and <=5000 ha	2.17	1028.69
>5000 ha and <=10,000 ha	0	0.00
>10,000 ha	0	0.00

East Ranchlands	**% of forest**	**area (ha)**
>2 ha	1.71	22.81
>2 and <=10 ha	20.68	275.19
>10 and <=50 ha	49.56	659.44
>50 and <=250 ha	26.88	357.63
>250 and <=500 ha	1.02	13.56
>500 and <=1000 ha	0.15	1.94
>1000 ha and <=5000 ha	0	0.00
>5000 ha and <=10,000 ha	0	0.00
>10,000 ha	0	0.00

FIGURE 25. ALPINE HIGH ROCK LMU DISTURBANCE PATCH SIZE DISTRIBUTION

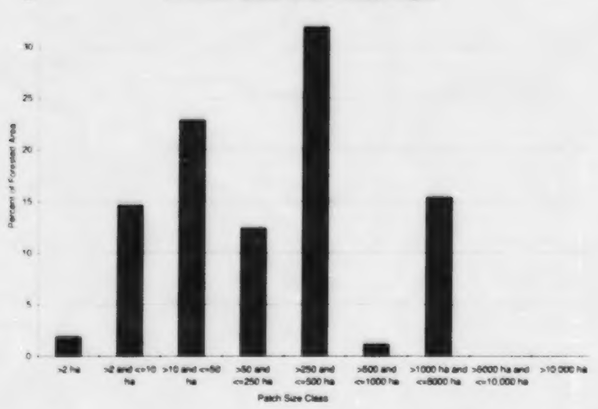


FIGURE 28. BEAVER LMU DISTURBANCE PATCH SIZE DISTRIBUTION

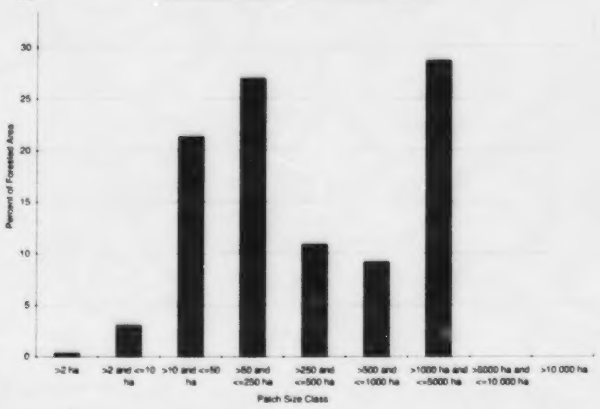


FIGURE 26. CHAPEL ROCK LMU DISTURBANCE PATCH SIZE DISTRIBUTION

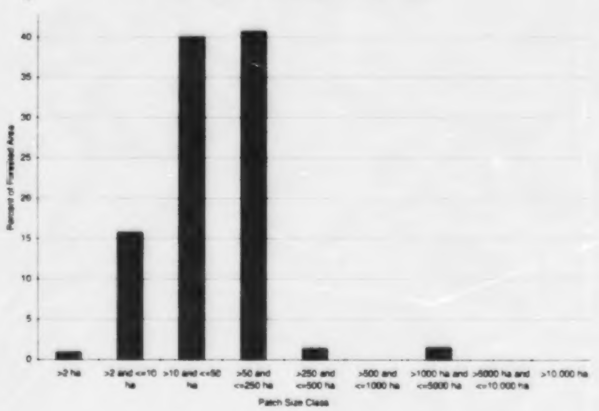


FIGURE 29. CROWSNEST PASS LMU DISTURBANCE PATCH SIZE DISTRIBUTION

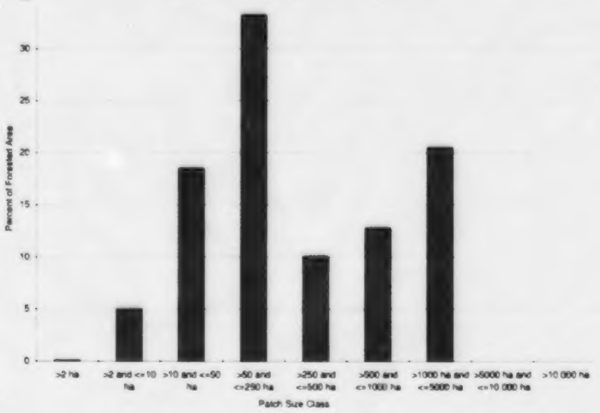


FIGURE 27. EAST RANCHLANDS LMU DISTURBANCE PATCH SIZE DISTRIBUTION

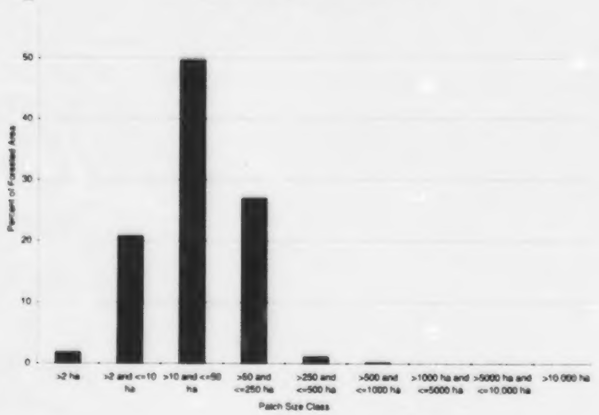


FIGURE 30. FLATHEAD LMU DISTURBANCE PATCH SIZE DISTRIBUTION

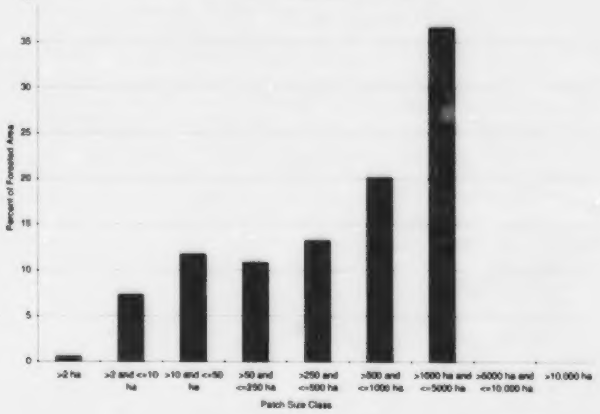


FIGURE 31. HEAD WATER VALLEYS LMU DISTURBANCE PATCH SIZE DISTRIBUTION

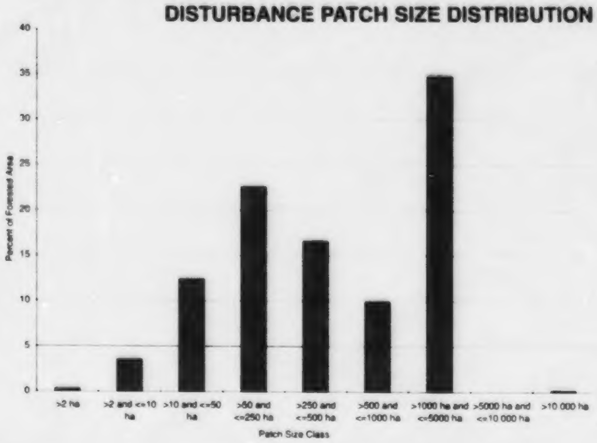


FIGURE 32. HORSESHOE PARKLAND LMU DISTURBANCE PATCH SIZE DISTRIBUTION

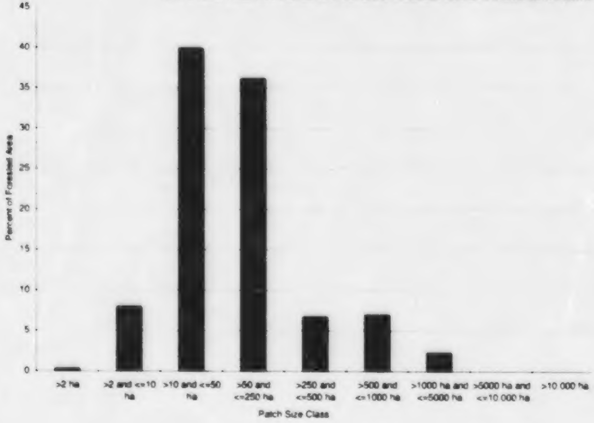


FIGURE 33. LIVINGSTONE VALLEY LMU DISTURBANCE PATCH SIZE DISTRIBUTION

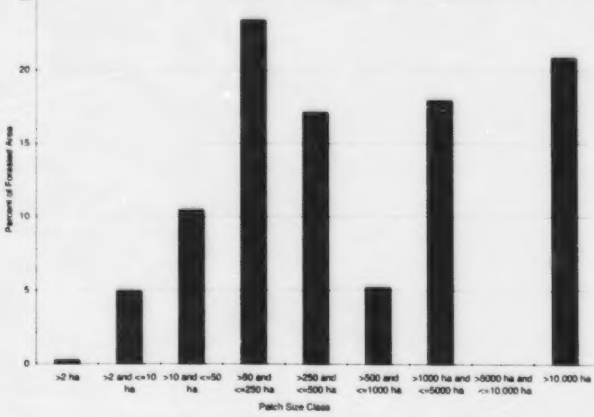


FIGURE 34. HILLCREST LMU DISTURBANCE PATCH SIZE DISTRIBUTION

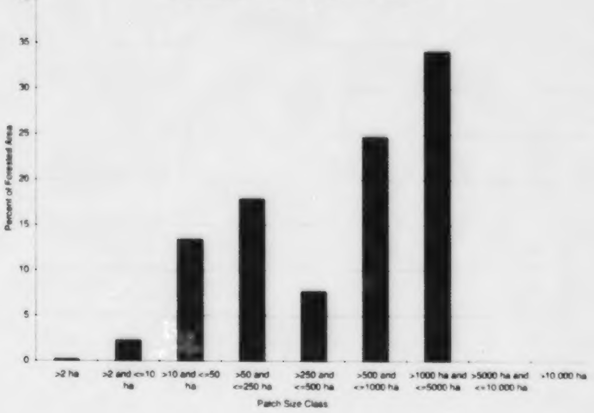


FIGURE 35. IRONSTONE LMU DISTURBANCE PATCH SIZE DISTRIBUTION

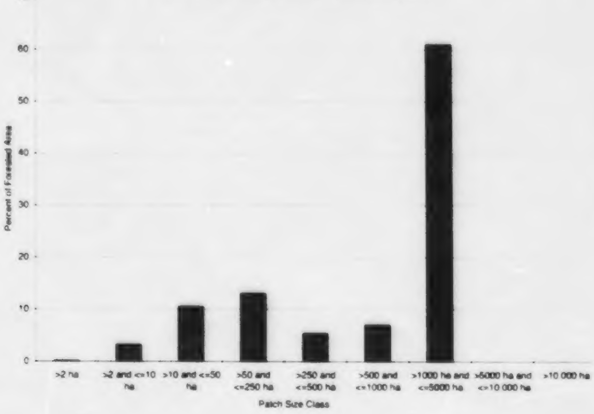


FIGURE 36. MIDDLE RIDGES LMU DISTURBANCE PATCH SIZE DISTRIBUTION

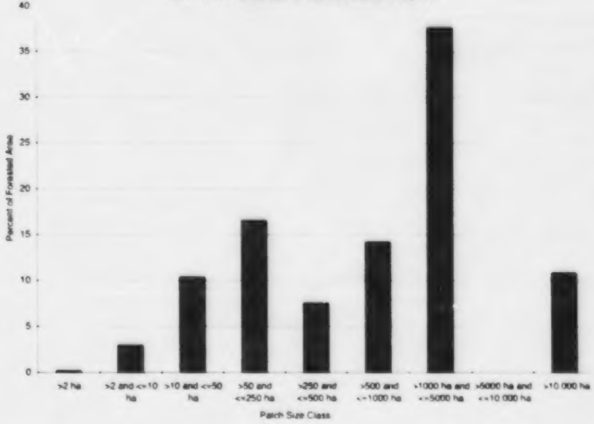


FIGURE 37. NORTH LIVINGSTONE LMU DISTURBANCE PATCH SIZE DISTRIBUTION

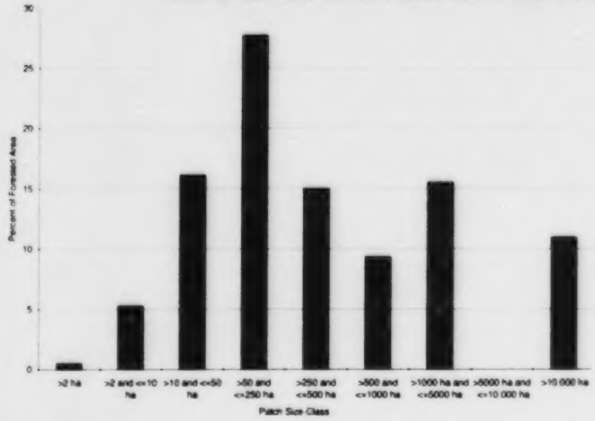


FIGURE 40. PORCUPINE HILLS LMU DISTURBANCE PATCH SIZE DISTRIBUTION

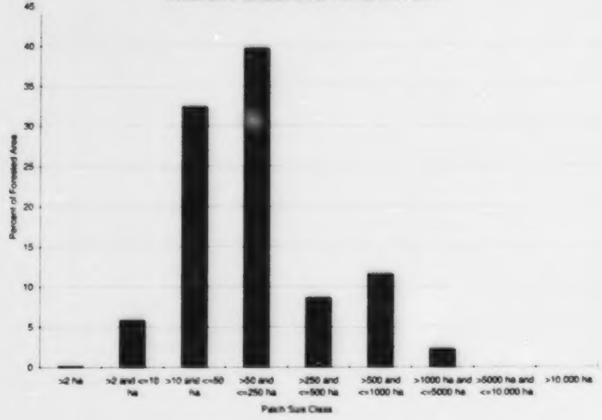


FIGURE 38. SADDLE MOUNTAIN LMU DISTURBANCE PATCH SIZE DISTRIBUTION

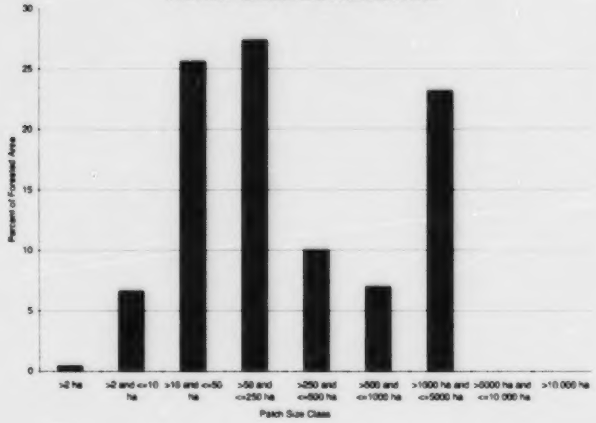


FIGURE 41. SOUTH FESCUE LMU DISTURBANCE PATCH SIZE DISTRIBUTION

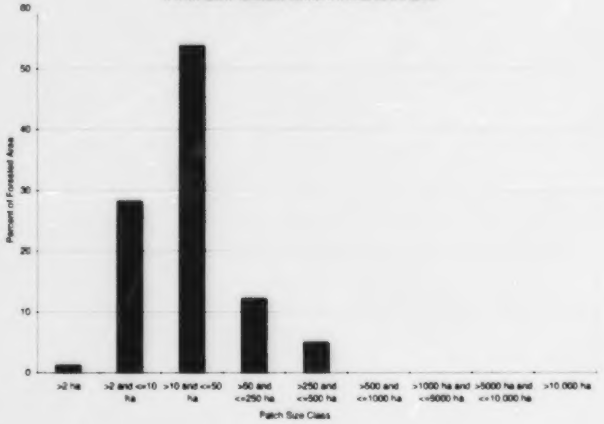


FIGURE 39. SOUTH LIVINGSTONE LMU DISTURBANCE PATCH SIZE DISTRIBUTION

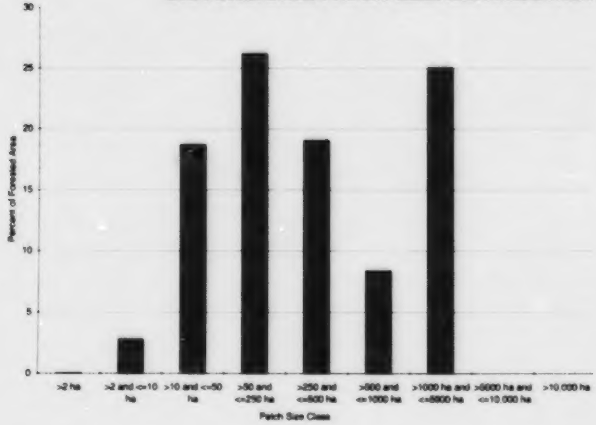
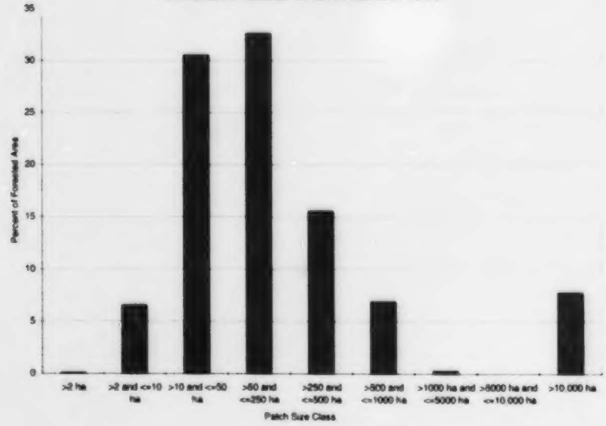


FIGURE 42. WHALEBACK LMU DISTURBANCE PATCH SIZE DISTRIBUTION



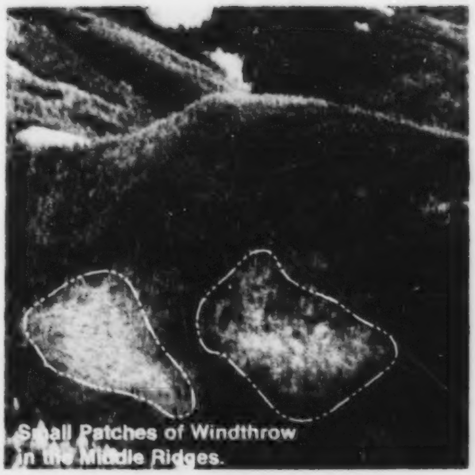
2.1.2.3 FIRE CYCLE ESTIMATES BY LANDSCAPE MANAGEMENT UNIT

The Fire Planning Unit (1998) calculated the fire cycle by landscape management unit utilizing the average area weighted age method (refer section 2.1.1.4). The subalpine areas have the longest cycle with the Head Water Valleys LMU being the longest in the study area. The fire cycle is based upon Alberta Vegetation Inventory (AVI) origin estimates.

TABLE 10. AVERAGE WEIGHTED AGE FIRE CYCLE ESTIMATES FOR LMUs

Landscape Management Unit	Average Weighted Age	Comments
Alpine High Rock	113 years	age class 1930–39 represents 38% of area
Beaver	80 years	age class 1920–29 represents 49% of area
Chapel Rock	75 years	age class 1920–29 represents 50% of area
Crowsnest Pass	86 years	age class 1890–99 represents 25% of area and age class 1920–29 represents 34% of area
East Ranchlands	57 years	age class 1940–69 represents 45% of area
Flathead	86 years	age class 1930–39 represents 65% of area
Head Water Valleys	135 years	
Hillcrest	83 years	age class 1900–09 represents 35% of area and age class 1920–29 represents 23% of area
Horseshoe Parkland	62 years	age classes 1920–29 and 1950–59 represents 20% of area
Ironstone	92 years	age class 1900–09 represents 23% of area and age class 1890–99 represents 30% of area
Livingstone Valley	115 years	age class 1870–79 represents 20% of area and age class 1910–19 represents 35% of area
Middle Ridges	105 years	
North Livingstone	99 years	age class 1910–19 represents 30% of area
Porcupine Hills	85 years	age class 1910–19 represents 19% of area and age class 1890–99 represents 20% of area
South Fescue	89 years	age class 1920–29 represents 30% of area and age class 1890–99 represents 25% of area
South Livingstone	78 years	age class 1910–19 represents 35% of area
Saddle Mountain	92 years	age class 1890–99 represents 32% of area
Whaleback	86 years	age class 1910–19 represents 35% of area

2.2 OTHER MAJOR NATURAL DISTURBANCE PROCESSES



Small Patches of Windthrow in the Middle Ridges.

While it has historically been one of the most powerful processes in the area, fire is by no means the only disturbance mechanism. Wind, insects and disease, landslides, logging, grazing, oil and gas exploration and production, and recreational use are the other main disturbance processes. With the notable exception of the Frank Slide, landslides are not a frequent occurrence and have not been investigated.

2.2.1 WIND

Southern Alberta and the Livingstone/Crowsnest Pass area in particular is subject to periods of very high winds. These winds can and do cause significant amounts of timber blowdown, particularly where stand boundaries are opened up through logging or where blocks have an excessively long wind run (fetch). Maps of windthrow hazard are found in the silvicultural typology and are based upon ecosite characteristics. Blowdown brought about through the funnelling of wind (venturi effect) is affected by the shape of patches. Orientation to prevailing winds, slope position, wind firmness of stand type boundaries and the adjacent stand characteristics are other determinants of windthrow risk. As most stands have developed their wind firmness over time, large amounts of blowdown in natural stands are relatively rare, even in this very windy area. Most blowdown is brought about through human induced openings for logging, roadways or transmission lines. However, natural blowdown does occur. The photograph below indicates two small openings of approximately .1 to .15 ha each. Typically such blowdown is found where there is a change from a moderate to a steep slope and the patch faces into the prevailing wind.

The Frank Slide was the most dramatic single disturbance event in the region.

2.2.2 INSECTS AND DISEASE AND PATHOGENS

Many pests and pathogens cause disturbance to forest stands in the area. However, it is the Mountain Pine Beetle that is considered the most destructive insect forest pest in the area (Miyagaw, 1994). The beetle population dynamics respond rapidly to optimal conditions and it therefore can spread exponentially over long distances. Several infestations of up to 4300 ha have been reported in the Southern Rockies since the 1940s.

Infestations have been noted on the Blairmore Ridge, the Porcupine Hills, the east side of the Livingstone Range as well as several other locations south of the study area. The extensive lodgepole pine stands (Pinus contorta) in the region make it susceptible to future outbreaks. Salvage cuts have been used in the past and were at least partially successful in slowing the outbreak. However, given the explosive nature of potential infestations, together with the ability of the beetle to enter the jet stream, only climate and stand characteristic manipulation can practically be expected to have a serious effect. Establishment of stands with greater species mix and greater variation in age and diameter are useful in reducing the intensity of infestations. In addition, changes in logging prioritization for stands at risk, together with density manipulation are considered helpful (Miyagawa, 1994).

The size and convoluted shape of Pine Beetle salvage cutblocks, together with their feathered edges and internal islands, provides an appropriate precedent for new openings that mimic the patch characteristics of insect disturbance.

2.3 MAJOR HUMAN DISTURBANCE PROCESSES

Human use of the region has altered natural disturbance processes and significantly changed land cover patterns in many portions of the study area. While the degree of influence of interventions such as fire control is difficult to determine, the areal extent of major human uses are more readily measured. The following table indicates the percentage of the study area in various anthropogenic land cover types. Roads, transmission lines and other linear features are dealt with in a following section.

TABLE 11. AREAL EXTENT OF ANTHROPOGENIC LAND COVER TYPES IN STUDY AREA

Land Cover Type	Area (ha)	% of Study Area
Annual Crops	1894.06	0.37%
Perennial Forage Crops	33,744.25	6.67%
Gravel Pits/Surface Mines	725.19	0.14%
Rural Residential	153.63	0.03%
Hamlets, Villages and Towns	520.25	0.10%
Non—veg ROWs	782.19	0.15%
Farmsteads	509.00	0.10%
Plant Sites/Sewage Lagoons	99.63	0.02%
Industrial Reclamation—Vegetated	218.31	0.04%
Herbaceous Clearcuts	3739.38	0.74%
Historical Clearcuts	6412.00	1.27%
TOTAL	**42,385.88**	**9.64%**

The above table indicates that, on a regional basis, almost 10% of the area has been heavily modified by man. The cover type with the largest areal extent is perennial forage crops, which have been converted from native vegetation. Areas that have been clearcut at some time in the last 120 year total, account for just over 2% of the area. Herbaceous clearcuts are those which are currently listed as lacking a leading tree species and are considered unforested. Historical clearcuts are those which are now considered forested and may date back as far as 1870. The Alberta Vegetation Inventory (AVI) was used to determine clearcuts, but those areas which were shown as clearcuts prior to 1870 were assumed to be data entry errors. Note that not all historical clearcuts have been identified on the AVI. Logging at the turn of the century is heavily regrown and is difficult to detect from aerial photo interpretation. The only evidence is old stumps and not all stands were visited on the ground. Annual crops account for only 0.37% of the area. Human settlements of some form (including rural residential and farmsteads) account for 0.23% (1182 ha) of the study area.

The various land covers are not distributed randomly as the following analysis by LMU indicates. Clearcuts are reported in a separate analysis. The following charts indicate that the Crowsnest Pass is the landscape that has been most heavily settled. Not surprisingly, the Fescue (East Ranchlands, South Fescue) and Montane (Porcupine Hills, Whaleback, Saddle Mountain, Chapel Rock) landscapes contain almost all the perennial and annual crops in the study area.

TABLE 12A. AREAL EXTENT (IN HA) OF ANTHROPOGENIC LAND COVER TYPES BY LMU

LMU	Annual Crops	Perennial Forage Crops	Gravel Pits Surface Mines	Rural Residential
Alpine High Rock	0.00	0.00	0.00	0.00
Head Water Valleys	0.00	0.00	208.56	1.50
Flathead	0.00	0.00	18.31	0.00
Crowsnest Pass	106.80	176.62	86.19	99.25
Middle Ridges	0.00	20.50	335.00	0.00
Ironstone	0.00	67.81	4.75	3.12
Hillcrest	0.00	3.94	0.00	5.69
North Livingstone	0.00	1.94	0.00	0.00
Livingstone Valley	0.00	2.31	2.00	0.00
South Livingstone	0.00	13.88	0.00	0.00
Beaver	7.81	394.00	0.00	5.75
Horseshoe Parkland	18.38	6843.12	1.06	2.38
Saddle Mountain	0.00	89.75	0.00	2.50
Whaleback	0.00	3226.19	0.62	0.00
Chapel Rock	113.06	3710.38	34.68	12.38
South Fescue	966.81	10,381.25	23.62	21.06
Porcupine Hills	90.81	4099.56	2.19	0.00
East Ranchlands	590.38	4713.00	8.19	0.00
TOTALS	**1894.06**	**33,744.25**	**725.19**	**153.62**

TABLE 12B. AREAL EXTENT (IN HA) OF ANTHROPOGENIC LAND COVER TYPES BY LMU

LMU	Hamlets, Villages and Towns	Farmsteads	Non−veg ROWs	Plant Sites/ Sewage Lagoons
Alpine High Rock	0.00	0.00	0.00	0.00
Head Water Valleys	0.00	0.00	174.44	0.00
Flathead	0.00	0.00	2.62	0.00
Crowsnest Pass	416.44	12.06	208.81	88.19
Middle Ridges	0.00	0.00	296.38	2.94
Ironstone	37.44	0.00	32.94	0.00
Hillcrest	11.75	0.00	0.00	0.0
North Livingstone	0.00	0.00	25.69	0.00
Livingstone Valley	0.00	0.00	41.31	2.38
South Livingstone	0.00	0.00	0.00	0.00
Beaver	11.25	5.75	0.00	0.00
Horseshoe Parkland	0.00	57.94	0.00	2.13
Saddle Mountain	0.00	0.00	0.00	0.00
Whaleback	0.00	17.25	0.00	0.00
Chapel Rock	0.00	71.44	0.00	0.00
South Fescue	43.38	201.31	0.00	0.00
Porcupine Hills	0.00	54.81	0.00	4.00
East Ranchlands	0.00	88.44	0.00	0.00
TOTALS	520.25	509.00	782.19	99.62

All areas in ha

2.3.1 ENERGY, EXPLORATION, PRODUCTION AND DISTRIBUTION CORRIDORS

Oil and gas operations are certain to continue throughout the region due to the substantial potential reserves. Seismic operations, wellsite development, pipeline and road construction are the main activities of disturbance. Recent seismic activities are usually portable helicopter operations and result in cutlines of narrower width. In some cases, these narrow cutlines provide corridors through densely forested areas, but their ecological impact is generally low and associated forest fragmentation issues are usually minor. However, in some areas, there is potential for visual impact due to the continuous forest cover and high visual sensitivity of much of the region.

Wellsite construction and maintenance, together with the associated human activity along roadways, is a potentially significant disturbance from a number of perspectives (impact of both construction and operation as well as that of access). Gas transmission lines and power lines fragment by dissecting natural patches and have associated ecological and visual impacts (Harris, 1994). The total "footprint" of the oil and gas operations in the area is noted on the map of energy related operations (Oil and Gas Footprint). Seismic lines, wellsites, transmission lines and associated roads are indicated.

A drilling rig near the Whaleback.

A power transmission line through the Whaleback LMU. Ecological impact is low but visual impact is high.

A wellsite in Middle Ridges LMU.

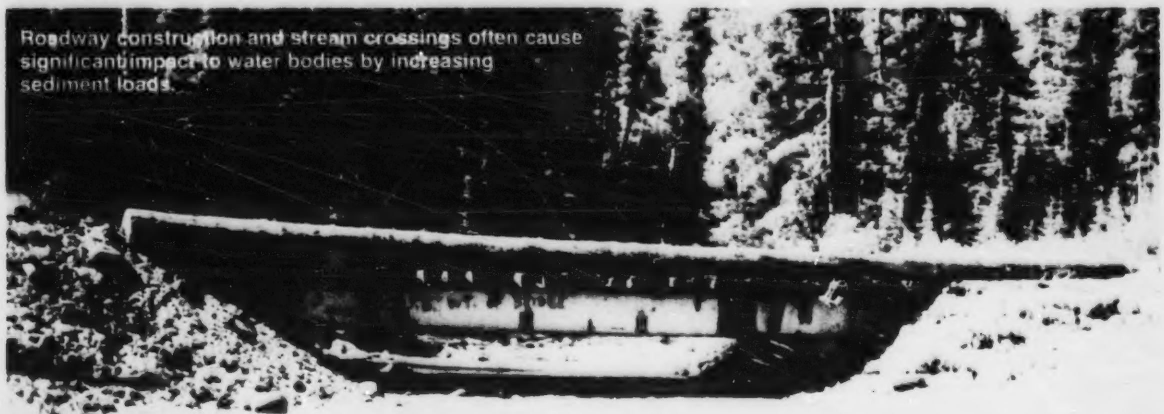
2.3.2 ROADS AND OTHER LINEAR DISTURBANCES

Much of the study area is easily accessible by roads and trails. Table 13 indicates that there are over 1280 km of roads in the area not including truck trails. There are over 6000 km of trails and cutlines in the area. These range in size from seismic lines and minor logging roads to little more than horse trails. A major rail line and a major highway (#3) run through the Crowsnest Pass. Highway #22 runs north/south along the west side of the Porcupine Hills. The revegetation status of the trials has not been confirmed and the length of current trails may be higher than actually exists.

Due to their extent, broad distribution and associated activities, roads have had the greatest ecological and visual impact of any human disturbance in the region to date. Both in terms of construction methods and access management, roads present one of the greatest challenges to planning. Roads are one of the major impacts on watersheds and often divert shallow subsurface flows to surface drainage swales, ditches and ultimately to streams. Bridges, culverts and stream crossings all have the potential to impact water quality. In addition, the access roads bring to otherwise remote areas cause significant impact on many wildlife species, particularly large carnivores. The visual impact of roads can be one of the most difficult aspects of logging to manage. The direct impact of loss of area to productive vegetative cover is significant as is the long—term reduction in productivity from skid trail construction.

TABLE 13. ROADS, RAILS, TRAILS AND TRANSMISSION LINES IN THE STUDY AREA

Access	KM
Runway Airfield	1.74
Road Gravel One Lane	375.13
Road Gravel Two Lane	139.35
Road Paved Undivided Two Lanes	165.76
Road Unimproved	608.58
Trail Cutline	6072.64
Trail Truck	197.74
Bridge Railway Trestle	0.37
Rail Line Single Track	52.34
Rail Line Spur	4.21
Major Pipeline	368.75
Transmission Line Major	163.20
SUBTOTAL	**8151.53**



Roadway construction and stream crossings often cause significant impact to water bodies by increasing sediment loads.

The following tables indicate the amount of access type by landscape management unit.

TABLE 14A. LENGTH OF ACCESS TYPE BY LANDSCAPE MANAGEMENT UNIT (LMU)

LMU	RUNWAY AIRFIELD	ROAD—GRAVEL 1 LANE	ROAD—GRAVEL 2 LANES	ROAD—PAVED UNDIV—2 LANES	ROAD UNIMPROVED
Alpine High Rock	0.000	0.000	0.000	0.000	0.000
Beaver	0.000	5.966	0.000	3.091	9.888
Chapel Rock	0.000	44.061	2.709	17.689	53.691
Crowsnest Pass	0.000	10.023	2.469	29.161	108.481
East Ranchlands	0.000	75.310	18.103	0.000	48.905
Flathead	0.000	0.000	0.000	0.466	2.589
Head Water Valleys	0.000	0.000	0.000	0.000	51.690
Hillcrest	0.000	3.288	0.000	0.000	2.976
Horseshoe Parkland	0.000	43.290	6.963	38.755	68.171
Ironstone	0.000	0.000	0.000	2.361	17.395
Livingstone Valley	0.000	0.803	40.157	0.000	9.513
Middle Ridges	0.000	0.000	38.558	0.000	70.984
North Livingstone	0.000	8.890	0.924	0.000	18.436
Porcupine Hills	0.000	58.544	13.548	11.464	72.305
Saddle Mountain	0.000	7.906	0.000	0.000	1.595
South Fescue	1.300	103.389	0.720	54.799	62.387
South Livingstone	0.000	0.000	0.604	0.000	0.000
Whaleback	0.000	12.451	14.486	7.976	9.270
TOTALS	**1.300**	**373.920**	**139.239**	**165.763**	**608.277**

TABLE 14B. LENGTH OF ACCESS TYPE BY LANDSCAPE MANAGEMENT UNIT (LMU)

LMU	TRAIL CUTLINE	TRAIL TRUCK	BRIDGE TRESTLE	RAIL LINE SINGLE TRACK	RAIL LINE SPUR	PIPELINE MAJOR	TRANSMISSION LINE MAJOR
Alpine High Rock	12.926	4.763	0.000	0.000	0.000	2.451	2.917
Beaver	117.715	2.115	0.000	0.000	0.000	5.544	12.516
Chapel Rock	250.740	17.538	0.185	10.408	0.898	37.653	25.791
Crowsnest Pass	134.774	11.362	0.000	34.423	3.315	18.026	27.335
East Ranchlands	111.051	15.799	0.000	0.000	0.000	0.000	0.000
Flathead	13.282	0.000	0.000	0.000	0.000	0.000	0.000
Head Water Valleys	634.825	40.599	0.000	0.000	0.000	17.285	0.690
Hillcrest	56.439	0.000	0.000	0.000	0.000	1.782	0.000
Horseshoe Parkland	865.531	20.799	0.000	0.000	0.000	74.832	29.319
Ironstone	169.554	1.086	0.000	0.000	0.000	9.678	0.000
Livingstone Valley	88.921	0.781	0.000	0.000	0.000	27.560	0.000
Middle Ridges	1060.870	26.608	0.000	0.000	0.000	39.602	15.120
North Livingstone	242.514	1.036	0.000	0.000	0.000	15.952	0.000
Porcupine Hills	1121.140	29.252	0.000	0.000	0.000	18.963	0.000
Saddle Mountain	399.141	1.823	0.000	0.000	0.000	8.456	7.911
South Fescue	144.496	16.745	0.000	7.531	0.000	75.267	4.053
South Livingstone	50.198	0.030	0.000	0.000	0.000	0.188	3.059
Whaleback	597.625	7.299	0.000	0.000	0.000	15.504	34.493
TOTALS	**6071.742**	**197.634**	**0.185**	**52.361**	**4.212**	**368.742**	**163.202**

2.3.3 ARABLE AGRICULTURE, PERENNIAL FORAGE PRODUCTION AND GRAZING

Perennial forage production, arable agriculture and grazing are extremely important components of the human use of the region. Cropping of the South Fescue and East Ranchlands LMUs is common and large areas of native grasslands have been converted to "tame" hay and annual crops. The impact on local ecosystems in those lands has been very high and species diversity has been reduced. Annual crops cover approximately 1894 ha or 0.37% of the total study area while perennial forage crops cover 33,744 ha or 6.67% of the area.

Grazing on native grasslands is extensive throughout the region both on private and public lands. Grazing throughout most areas is well managed and has in many ways maintained both native grasslands and an important cultural landscape. Grazing allotments and productivity are indicated in the allotment and productivity maps at the end of the document.

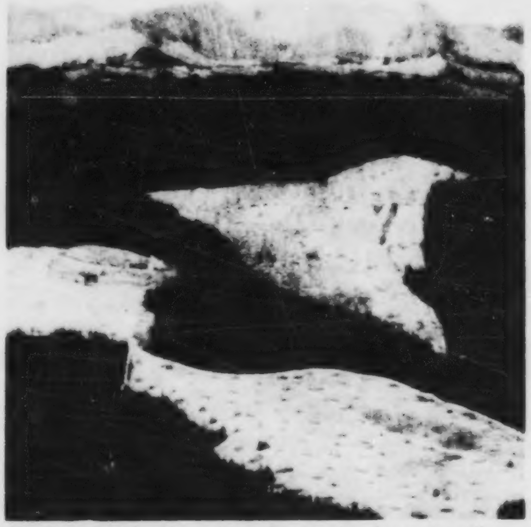
Perennial forage, annual crops, riparian forest and grasslands along the Oldman River in the Foothills Fescue Landscape Management Unit.

Perennial forage crops and grazing in the Foothills Fescue Landscape Management Unit.

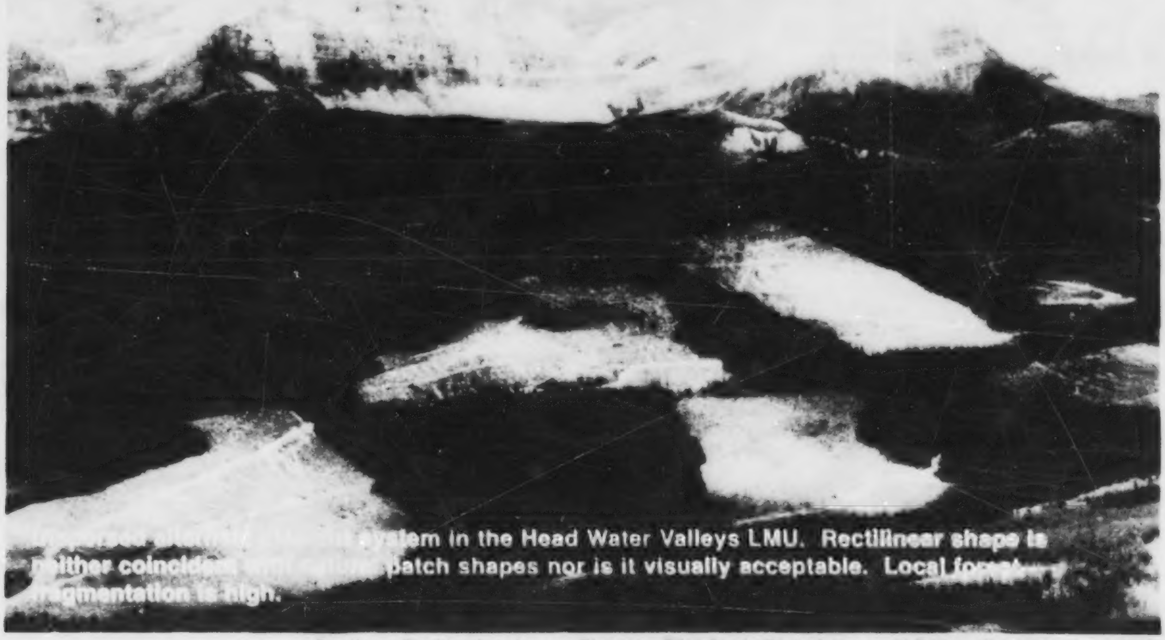
2.3.4 FORESTRY OPERATIONS

The use of the region for forest production dates to the last century (McMillan, 1909) when operations concentrated mainly in the vicinity of the Crowsnest Pass. However, the vast majority of the area has never been cut and continuous forest cover is present over much of the region. Recent forestry operations have concentrated in the Head Water Valleys LMU where the impact on patch size, landscape connectivity, age class distribution, species composition, visual quality and long—term site productivity has been high. Significant cutting has also occurred in the Porcupine Hills LMU. As Table 15 indicates, there has been limited cutting in other LMUs. As indicated previously, detection of old cuts was difficult and the statistics on cutting do not reflect cutover areas that are now completely reforested. There may have been cutting in areas that have not been identified as historical clearcuts.

A dispersed system of alternate patch clearcutting is the standard silvicultural system in place throughout most of the region. Other possible systems for the area are outlined in the Silvicultural Typology report (Olson+Olson 1997) but they



Alternate patch clearcutting. First pass clearcuts with relatively straight, high contrast edges (no feathering). Heavy scarification has occurred resulting in a high percentage of bare ground. The shallow soils and steep slopes on many sites makes the scarification techniques potentially damaging to long—term site productivity.



Dispersed alternate [illegible] system in the Head Water Valleys LMU. Rectilinear shape is neither coincident with natural patch shapes nor is it visually acceptable. Local forest fragmentation is high.

are **not** currently in place. The shape and configuration of the alternate patch system does not approximate the natural disturbance regime and in time this pattern will result in a high degree of forest fragmentation.

The impact on patch size may be very profound if the current cutting systems are maintained. Size class distribution of the clearcuts in the region is compared in the following charts to that of the size class distribution of the inherent disturbance regime (using the inferred data and filling in clearcuts with the most frequently occurring origin value surrounding the block). A percentage of the total forested area and a percentage of the total area of clearcuts is used to allow a comparison.

The current clearcut sizes are not coincident with the size of natural disturbances of the past century. The clearcuts are much smaller than the disturbance analysis would suggest for both the region and the Head Water Valleys where most cutting has occurred and where the divergence is pronounced. It should be noted that the companies are following the current Provincial operating ground rules and the Forest Management Plan for the area.

TABLE15. AREAL EXTENT OF CLEARCUTS BY LMU

LMU	Area in hectares
Alpine High Rock	11.8
Crowsnest Pass	55.4
Flathead	2.3
Head Water Valleys	4021.3
Horseshoe Parkland	39.8
Ironstone	15.0
Livingstone Valley	75.9
Middle Ridges	841.5
North Livingstone	282.4
Porcupine Hills	2024.6
Saddle Mountain	31.9
South Fescue	38.4
Whaleback	381.9

FIGURE 43. COMPARISON OF PATCH SIZE DISTRIBUTION STAND ORIGIN VS CLEARCUTS – REGION

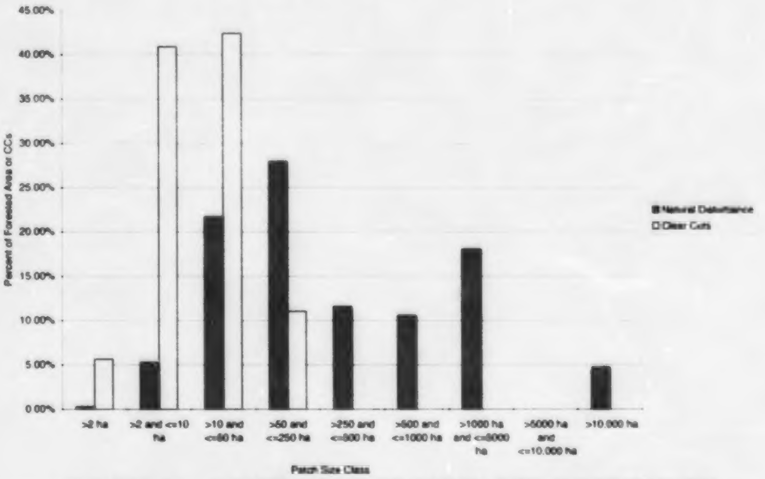
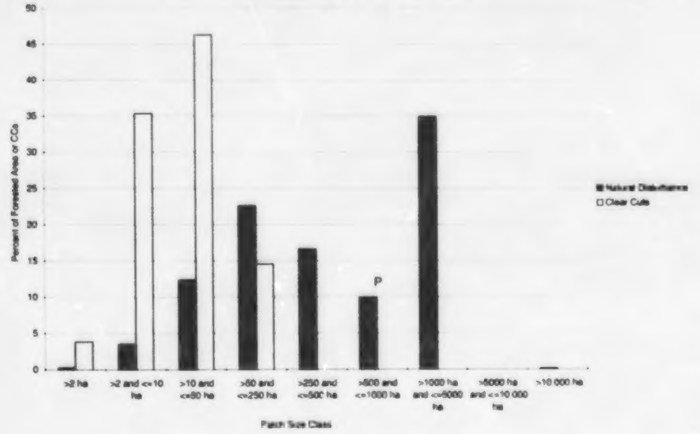
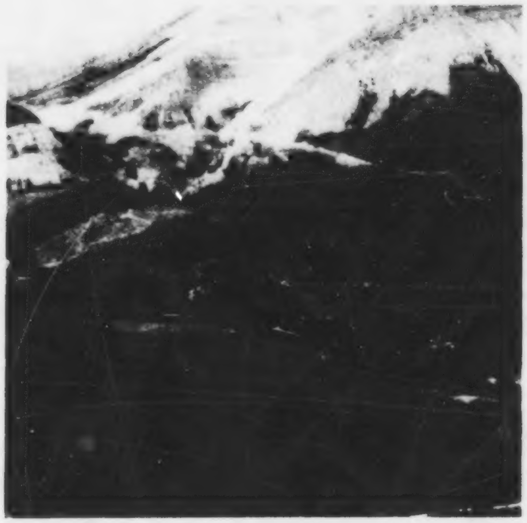


FIGURE 44. COMPARISON OF PATCH SIZE DISTRIBUTION STAND ORIGIN VS CLEARCUTS – HEAD WATER VALLEYS





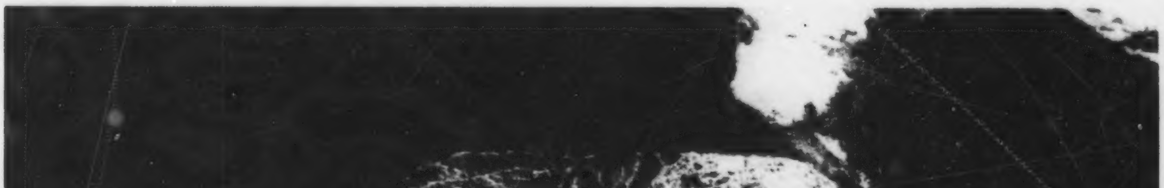
Recent cuts with boundary following elevation line. Fire would not have resulted in this pattern and a curvilinear edge would have been more appropriate. The roadway at the tree line has resulted in a long—term visual scar.

First pass clearcuts with a dispersed pattern. Large patches are not retained long into the cut cycle and fragmentation occurs in the first pass. Stepping stones and corridors across altered landscapes are required throughout the cutting sequence, not only during the first pass.

Dispersed alternate patch clearcut system in the **Head Water Valleys** indicating rectilinear cutting. **An alternative pattern would be an aggregated disturbance mimicking the shape** and extent of fire. This would result in larger **initial openings but would retain large patches** of residual longer into the rotation.

Large woody debris piles created for furbearers. The piles are tall to allow for high snow depths. This internal cutblock structure has little precedent in natural form, but provides important habitat.

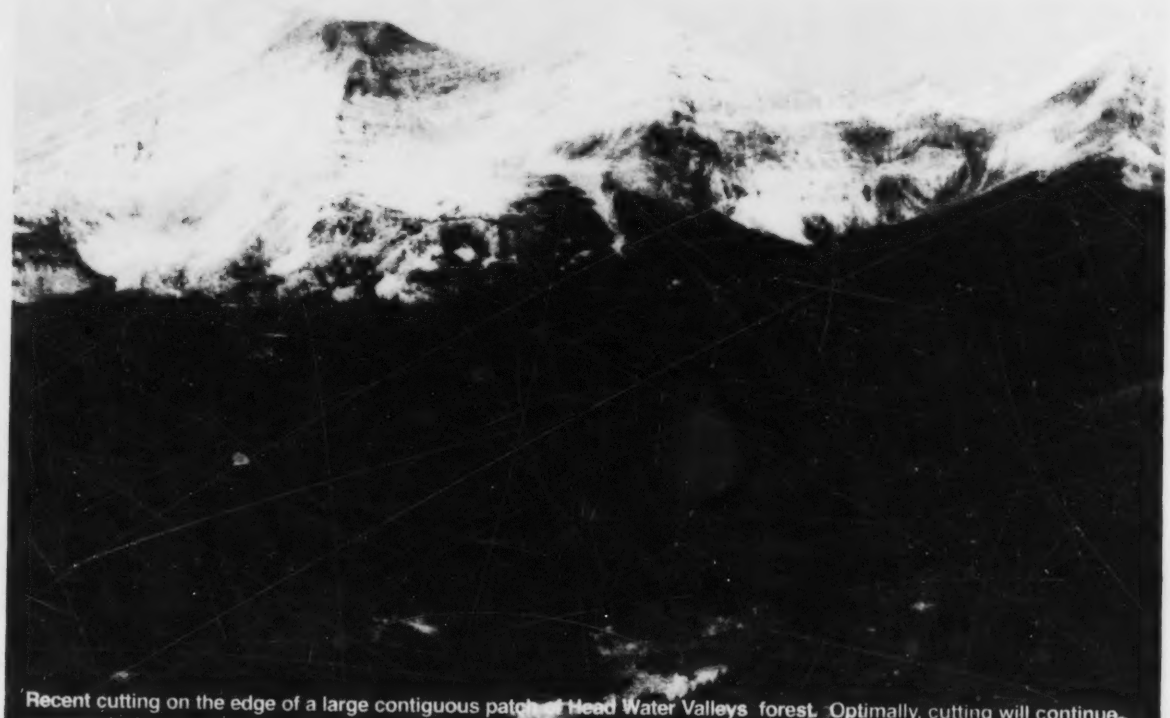
Debris piles created in an unnatural "polka dot" pattern across a recent cutblock. As the importance of large woody debris in cutover areas is clear, provision of this component should include visual quality considerations. The straight lines of the block are visually negative.



Adjacent cutblocks indicating residual leave corridors. The corridors lack an interior core and may not be providing adequate connectivity between residual areas for some species. The long-term impact of roads and skid trails on site productivity is significant. Edges should follow natural stand lines and topography wherever possible. Deep scarification has occurred on steep slopes.

Alternate patch cutting in the Middle Ridges. Patch size is far smaller than the inherent disturbance patches. Greater effort is required to give a more natural and curvilinear form to the cutblocks. Natural openings throughout the area should be used as a precedent for establishing the shape of blocks.

Cutting pine in the Porcupine Hills. Over 2000 ha have been cut in this LMU.



Recent cutting on the edge of a large contiguous patch of Head Water Valleys forest. Optimally, cutting will continue progressively from the edges, thereby retaining corridors and stepping stones through the altered landscape while at the same time retaining large well connected patches of uncut forest long into the cut cycle. Alternate patch cutting may fragment this forest on the first pass.

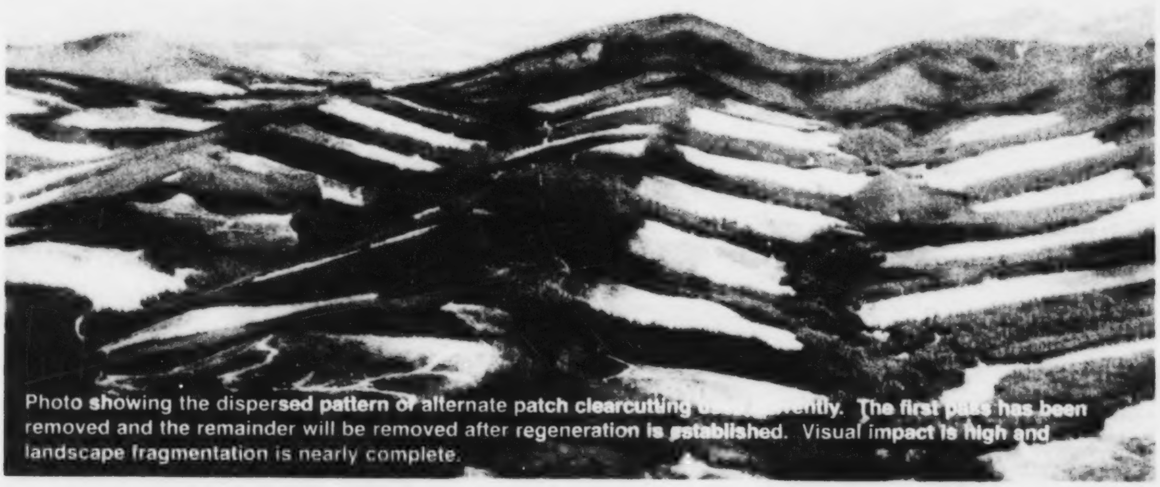
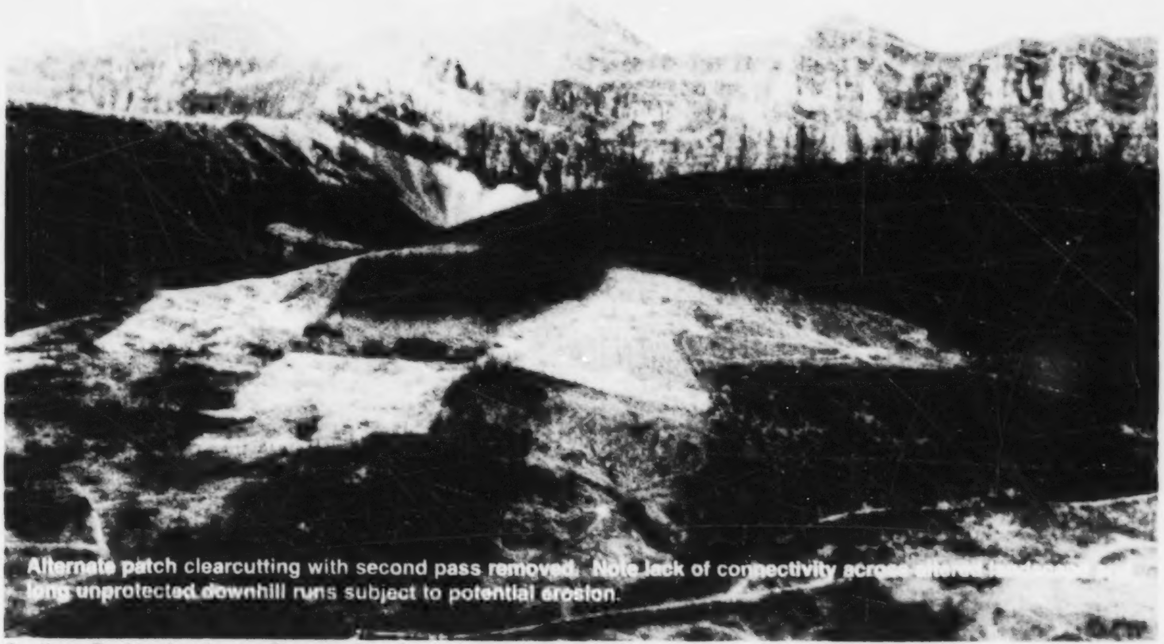
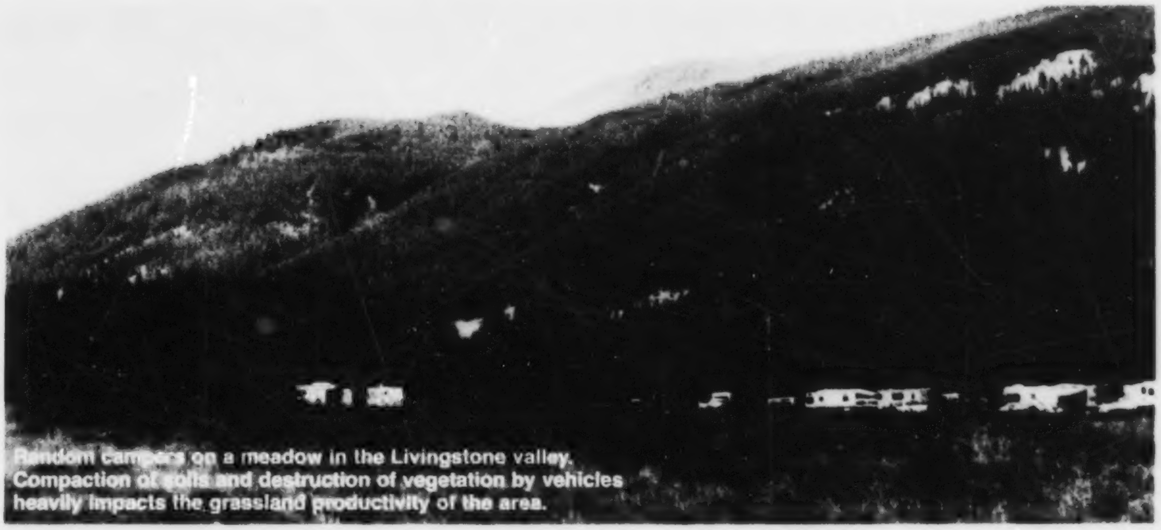


Photo showing the dispersed pattern of alternate patch clearcutting [illegible] currently. The first pass has been removed and the remainder will be removed after regeneration is established. Visual impact is high and landscape fragmentation is nearly complete.



Alternate patch clearcutting with second pass removed. Note lack of connectivity across [illegible] long unprotected downhill runs subject to potential erosion.



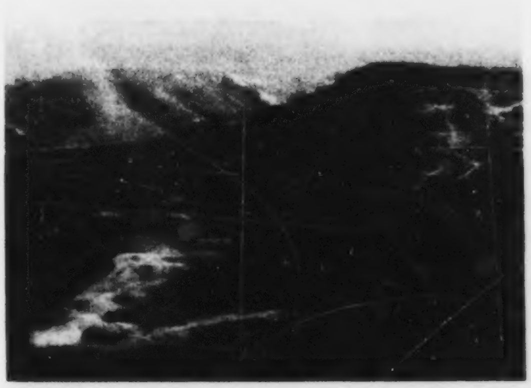
Random campers on a meadow in the Livingstone valley. Compaction of soils and destruction of vegetation by vehicles heavily impacts the grassland productivity of the area.

2.3.5 RECREATIONAL USE

Recreational activities including campgrounds, random camping areas and both motorized and non motorized use of the backcountry have all impacted the landscape to varying degrees. Increasing populations both in and beyond the study area are placing additional demands on the resource base and will need to be managed carefully in order to prevent significant impacts.

Random camping is having a major impact, particularly on grasslands and shrub meadows near water bodies where multiple trails are formed and compaction of soils is extensive. Backcountry use by motorized vehicles is becoming a serious issue. Motorcycles, quads, dune buggies and 4x4s are extending their use beyond logging roads and trails. There currently is no access management in the area other than exclusion from designated ecological reserves.

[illegible] meadows [illegible] [illegible] ntage of the [illegible] [illegible] in those areas [illegible] [illegible] Recovery [illegible] damage is [illegible] [illegible] but is [illegible]



Abandoned open pit mine just north of Crowsnest Pass.

Gravel burrow pits are localized and are generally small disturbances.

2.3.6 MINING

While mining was once one of the major economic forces in the area, all the major mines in the area have been abandoned. Aggregate deposits are mined throughout the study area, but generally in small localized burrow pits.

2.3.7 SETTLEMENT

Hamlets, villages and towns cover over 520 ha of the study area while rural residential and farmsteads account for 153 ha and 509 ha respectively. The attractiveness of the area for human habitation is undeniable and the settlements of the Crowsnest Pass in particular are likely to experience increased growth in the near future. While the communities of Blairmore, Coleman, Hillcrest and Frank have actually decreased in population since the early 1980s, this trend is not likely to continue. The closure of coal mines several years ago had a major impact on local populations. According to the Municipality of Crowsnest Pass (1998), the population of the settlements in the Pass since 1980 were as follows:

Year	**1980**	**1982**	**1986**	**1991**	**1997**
Population	7340	7577	6912	6679	6356

The increase in real estate and development in the area in recent years is masked by the apparent trend that these numbers indicate. The access from the major urban centres of Lethbridge and Calgary is excellent and recreational use of the area is increasing at a rapid rate. Holiday homes are becoming much more common in the Crowsnest Pass. It is expected that development in the area will significantly increase in the near future.

Human settlement in the Crowsnest Pass is poised to greatly expand.

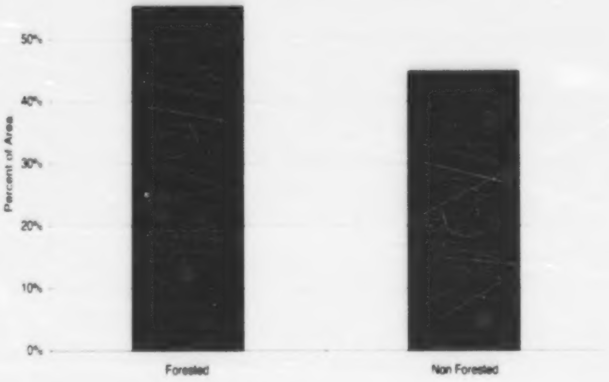
3.0 OTHER PATTERN ANALYSES

In addition to the age class and disturbance patches, analysis was carried out using a number of different patch definitions. Patch definition must be relative to the process under investigation and, as several scales of patch resolution may be important in the study, landscape characterization used several definitions of patches including forest or non forest, broad cover classes (coniferous, deciduous, mixedwood, grassland), ecosite, ecosite phase and ecosite phase by maturity class (the finest level of classification). The various levels of patch definitions were used to compare the utility of the coarse versus the fine filter approach. The broad cover class map was also analysed for connectivity of the various classes. Patch area distribution, size, shape, diversity and richness was analysed. In addition, edge conditions were examined and a generalized overall landscape pattern was mapped. All analysis was carried out at the scale of the region as well as that of its constituent landscapes.

3.1 FORESTED AND NON FORESTED LANDS

The most aggregated definition of a patch was Forested versus Non Forested. The following charts indicate that 55% of the total study area is considered as forested while 45% is non forested. This is highly variable within the landscape management units with extremes of forest cover ranging from 5% to 95% with the reciprocals for non forest lands. Analysis of the sizes of these patches was also carried out and is reported by LMU. Forested areas display a high degree of connectivity with the vast majority of most LMUs in the size class over 1000 ha. As maintenance of large patches of natural vegetation is seen as an important aspect of ecological integrity, the results of this measure are encouraging.

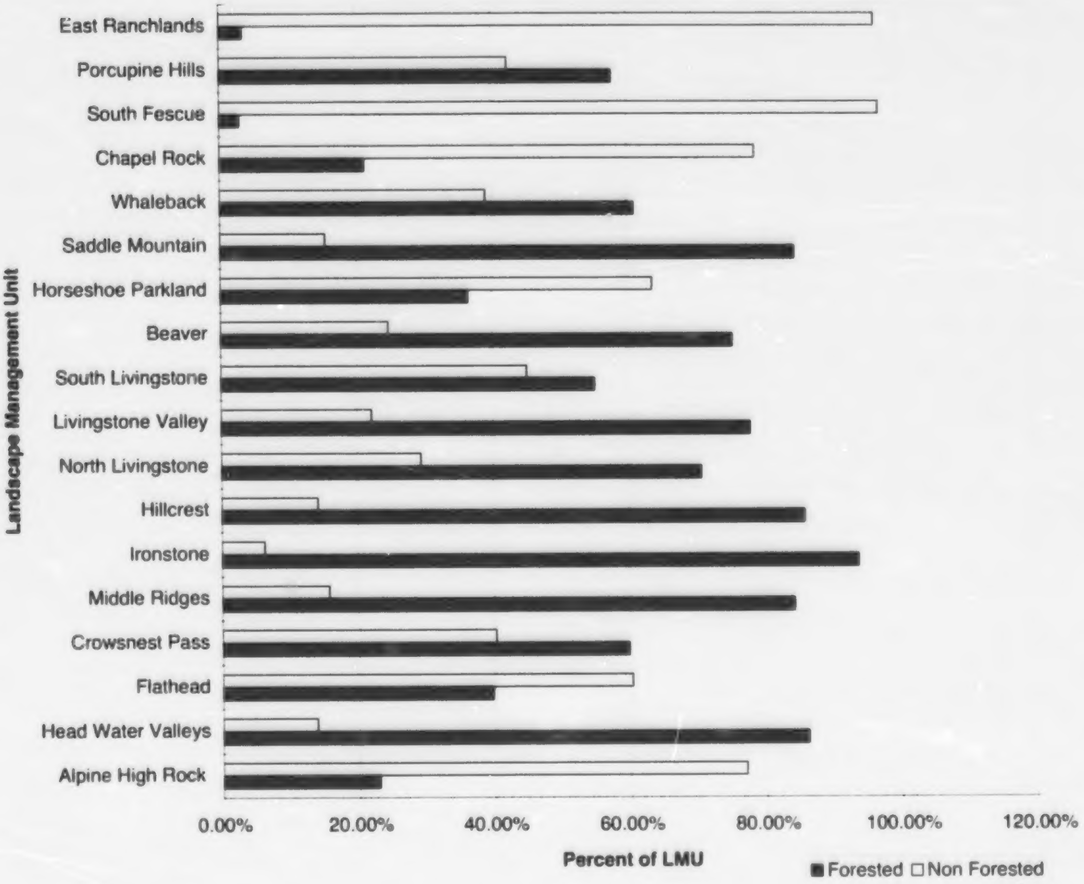
FIGURE 45. FORESTED VS NON FORESTED LANDS (PERCENTAGE OF REGION)



The level of fragmentation occurring through road construction, harvesting, energy production and other development activities has still left relatively large patches throughout the region. The effects of these activities are not evenly distributed. First, the inherent or naturally occurring patch size varies by landscape due to physiographic and other influences. Second, activity has been selectively located. The impacts of fragmentation of forest lands are most evident in the Head Water Valleys LMU where cutting and roading has been extensive. Fragmentation of vegetation through harvesting should be considered relatively short—term as the patch will merge with the surrounding matrix as the vegetation matures. However, it is important to ensure that critical landscape connections are maintained throughout this regeneration period.

Forested and Non Forested Lands in the Beaver and Crowsnest LMUs.

FIGURE 46. FORESTED — NON FORESTED LANDS (PERCENTAGE OF LMU)



Forested and Non Forested Patches in the Crowsnest LMU

FIGURE 47. FORESTED PATCH SIZE DISTRIBUTION (PERCENTAGE OF LMU)

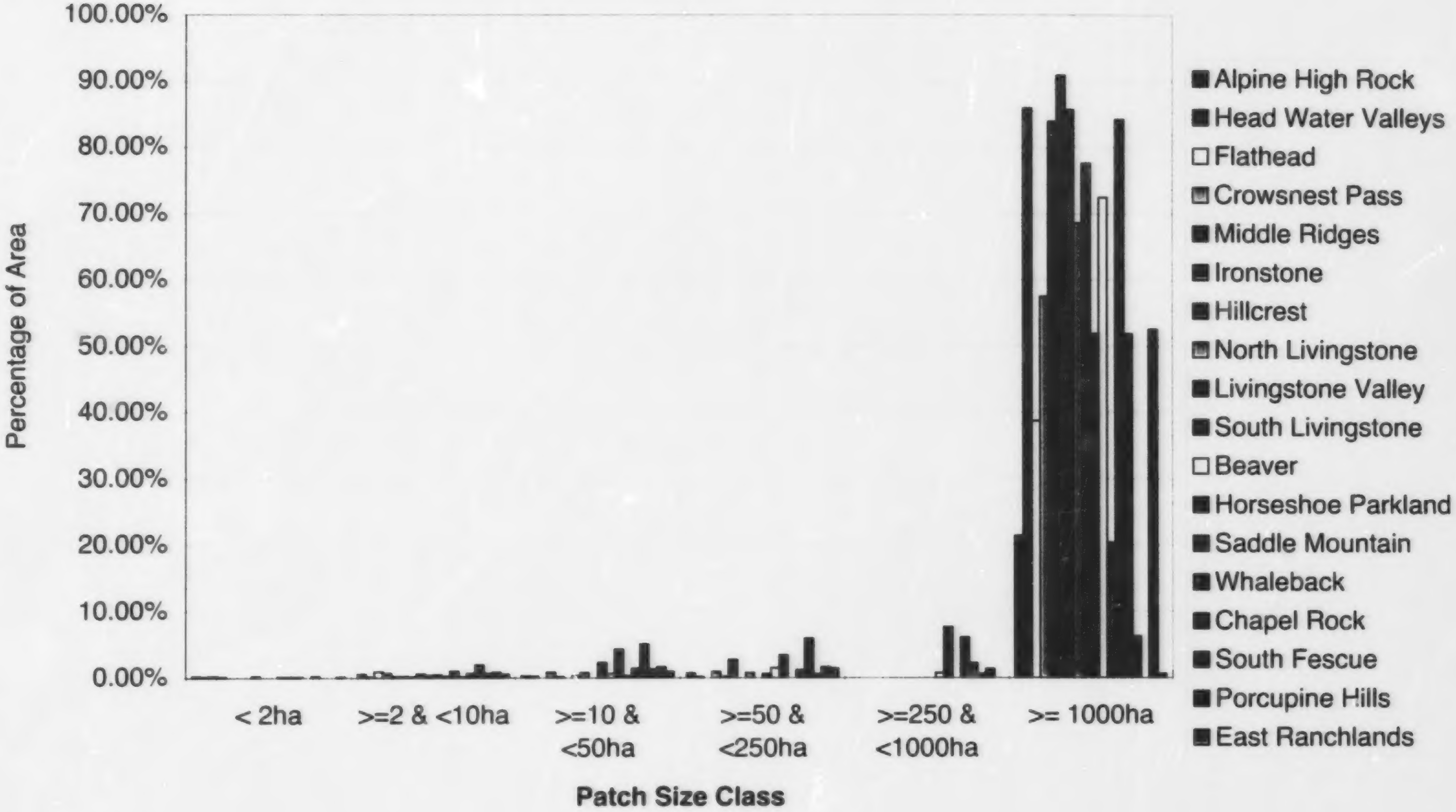
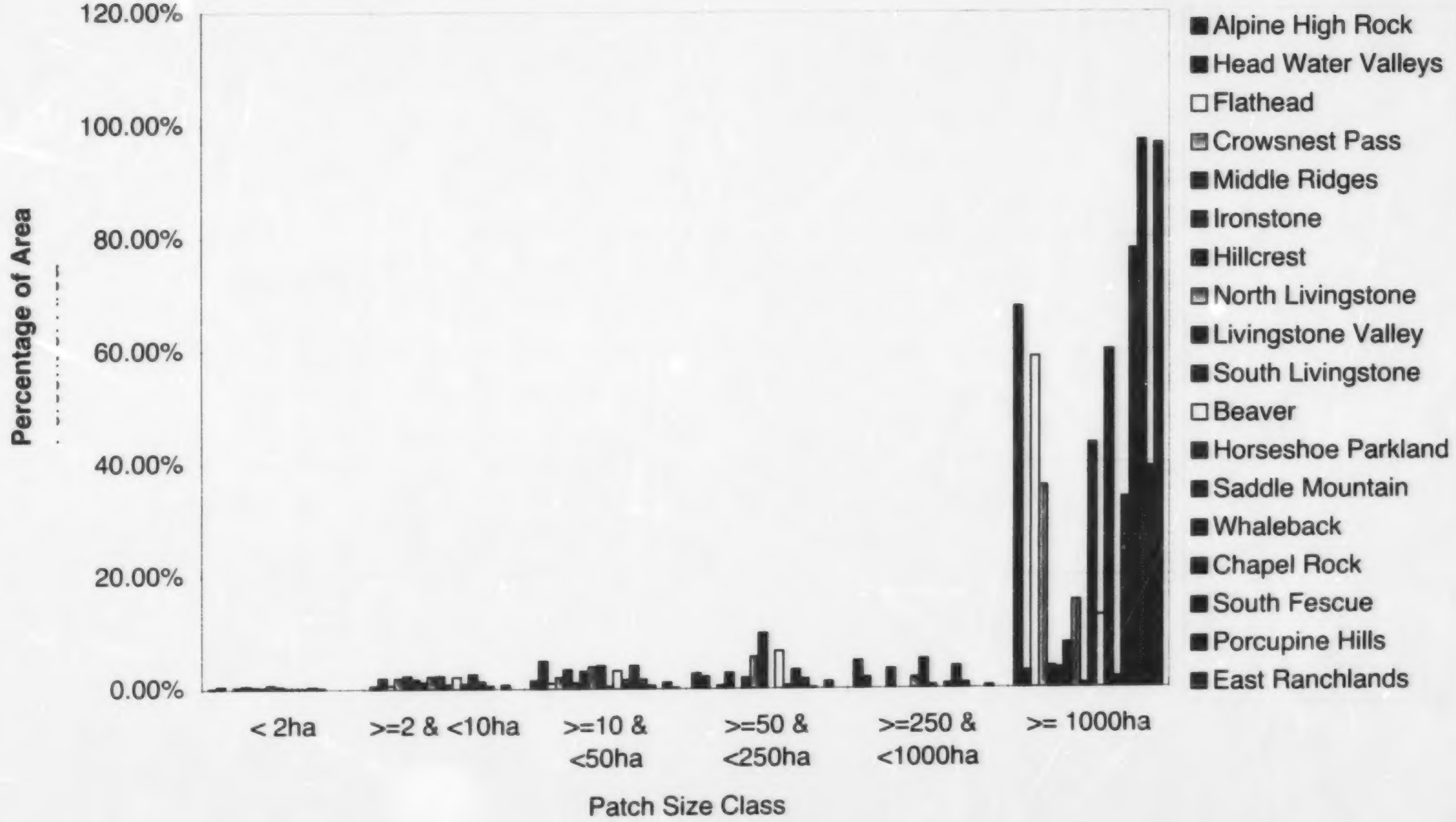


FIGURE 48. NON–FORESTED PATCH SIZE DISTRIBUTION (PERCENTAGE OF LMU)



3.2 CONIFEROUS, DECIDUOUS, MIXEDWOOD, GRASSLAND PATCH SIZE

The landbase was classified into coniferous, deciduous, mixedwood, grassland and other patches and clumped into contiguous patches. These were further classified into size classes and reported for the region as well as for the individual landscape management units. At the regional scale and at this level of aggregation, patch size is still largely predominated by very large patches in the grassland and coniferous types (refer to Figure 49).

The characterization of both the region and the individual landscapes by this coarse aggregation is an extremely important measure by which overall regional and landscape change may be easily identified and measured. Field studies (Ursus, 1997) have indicated that avian biodiversity can be correlated with these classes and that there is considerable variation between classes with mixedwood and deciduous showing the highest diversity. This characterization of existing conditions provides an important departure point for the development of regional and landscape pattern objectives. Figures 50 — 68 indicate that there is considerable variation by landscape management unit.

FIGURE 49. REGIONAL CONIFEROUS, DECIDUOUS, MIXEDWOOD AND GRASSLAND PATCH SIZE

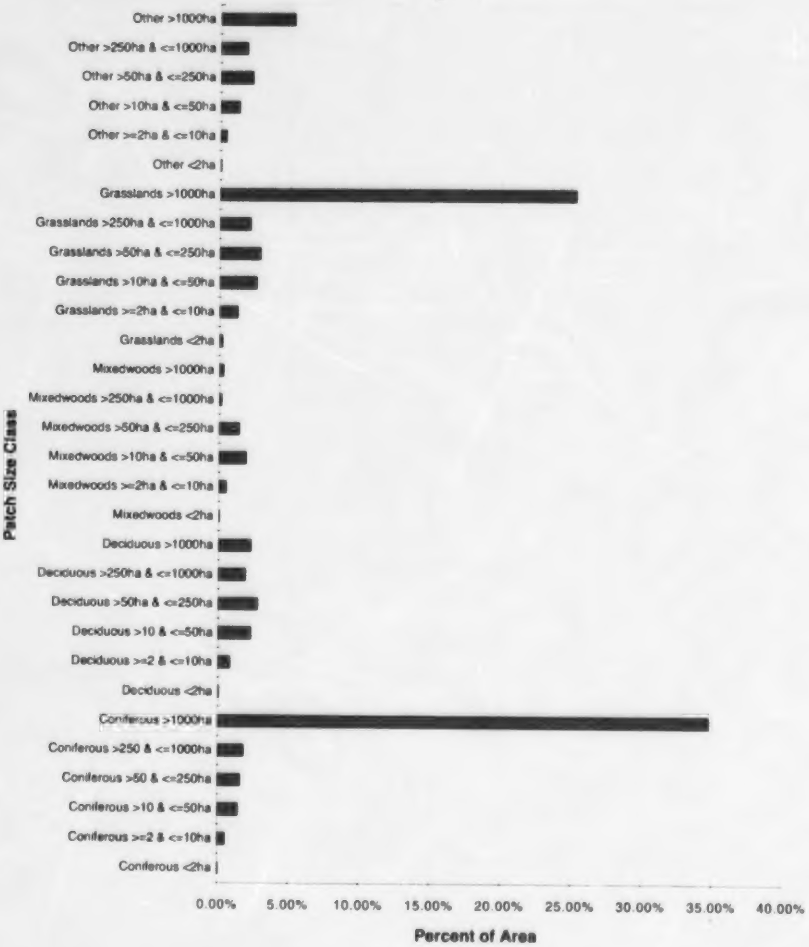


FIGURE 50. ALPINE HIGH ROCK LMU DISTRIBUTION FOREST LANDBASED PATCH SIZE

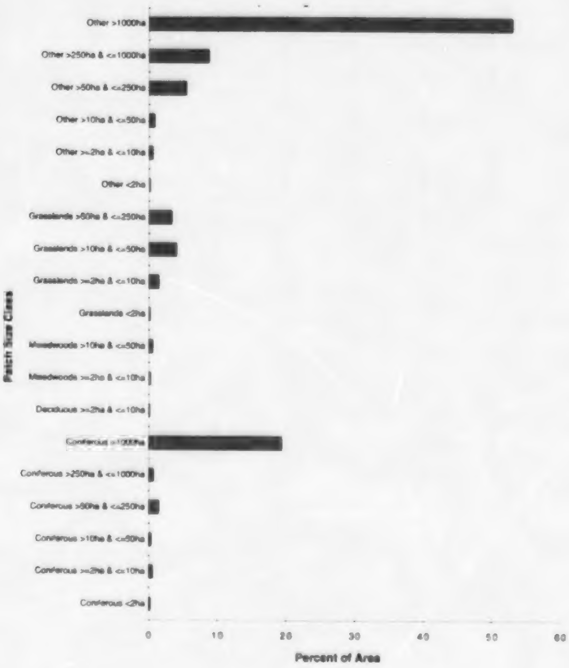


FIGURE 51. BEAVER LMU DISTRIBUTION FOREST LANDBASED PATCH SIZE

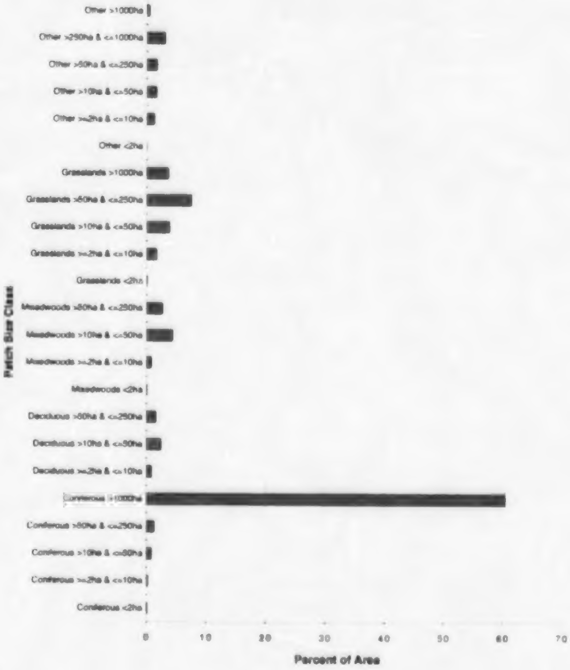


FIGURE 52. CHAPEL ROCK LMU DISTRIBUTION FOREST LANDBASED PATCH SIZE

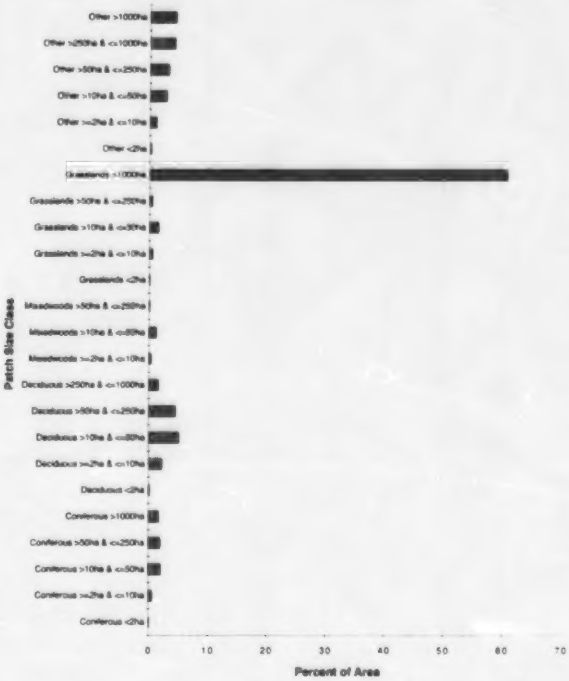


FIGURE 53. EAST RANCHLANDS LMU DISTRIBUTION FOREST LANDBASED PATCH SIZE

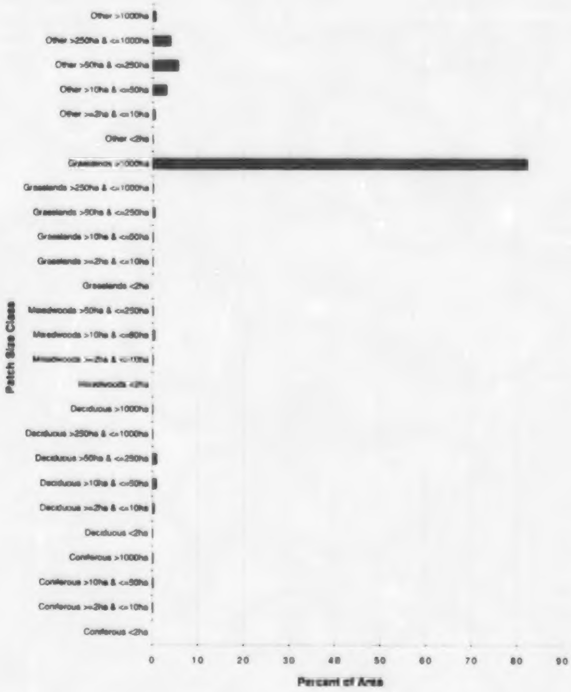


FIGURE 54. FLATHEAD LMU DISTRIBUTION FOREST LANDBASED PATCH SIZE

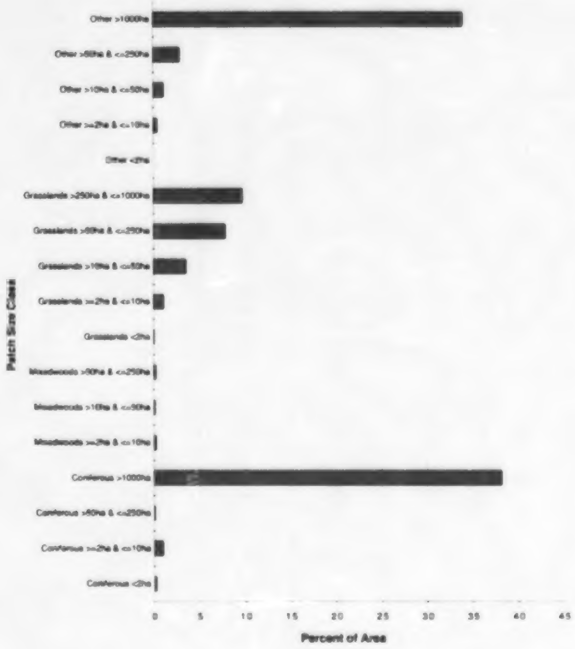


FIGURE 55. HEAD WATER VALLEYS LMU DISTRIBUTION FOREST LANDBASED PATCH SIZE

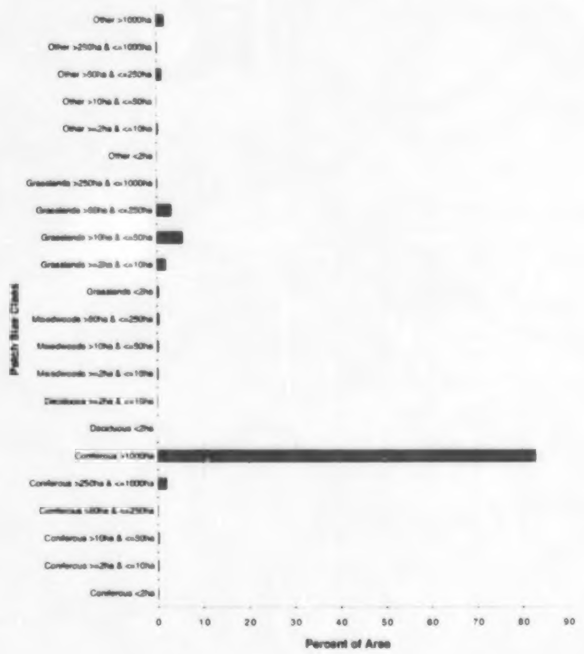


FIGURE 56. HILLCREST LMU DISTRIBUTION FOREST LANDBASED PATCH SIZE

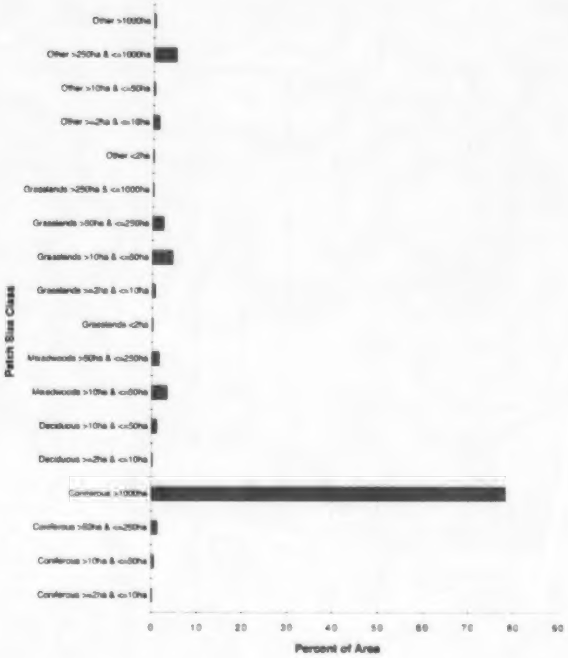


FIGURE 57. LIVINGSTONE VALLEY LMU DISTRIBUTION FOREST LANDBASED PATCH SIZE

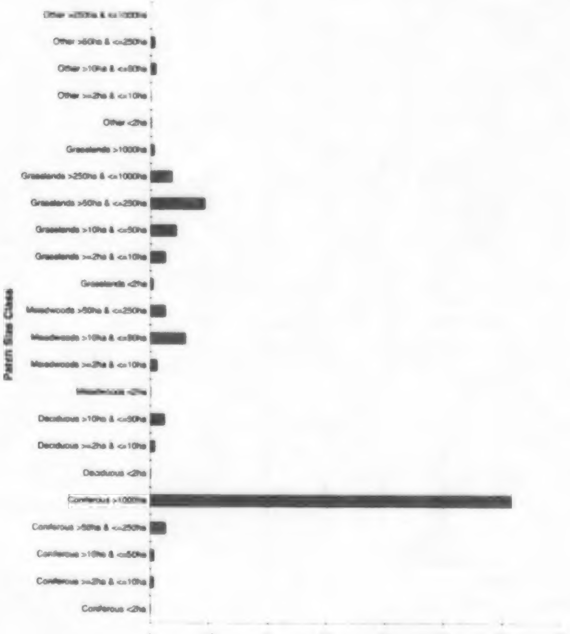


FIGURE 58. MIDDLE RIDGES LMU DISTRIBUTION FOREST LANDBASED PATCH SIZE

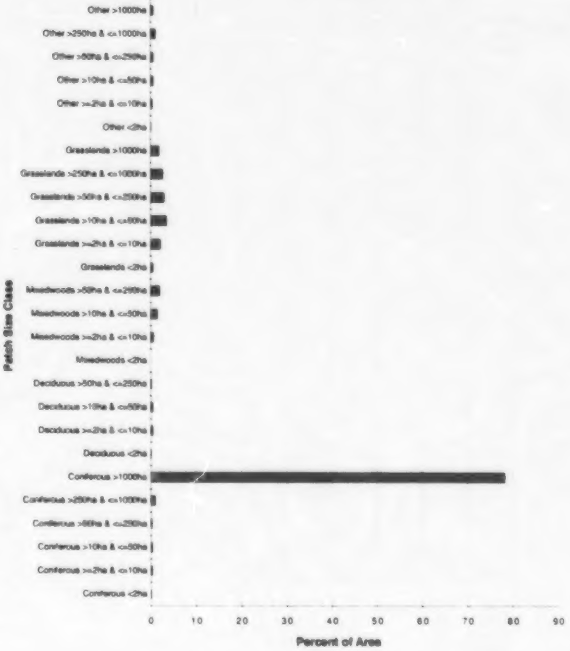


FIGURE 59. NORTH LIVINGSTONE LMU DISTRIBUTION FOREST LANDBASED PATCH SIZE

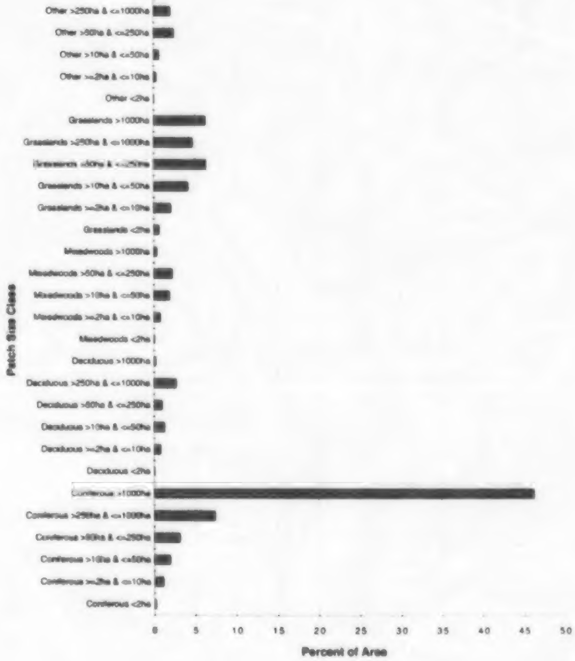


FIGURE 60. PORCUPINE HILLS LMU DISTRIBUTION FOREST LANDBASED PATCH SIZE

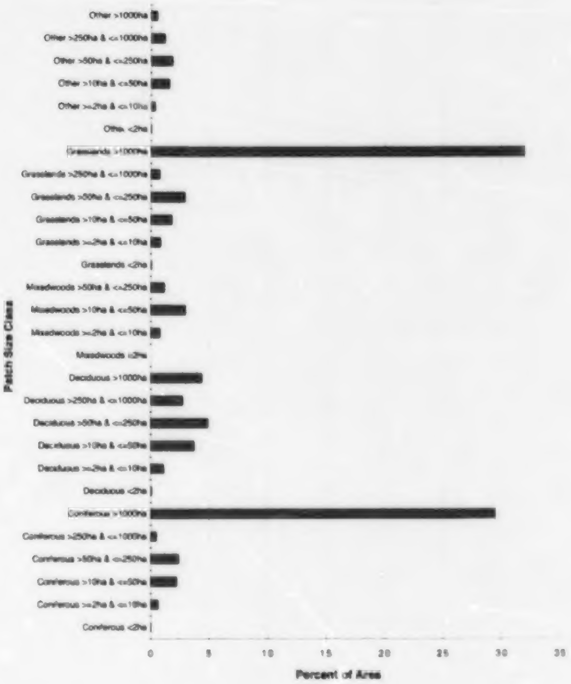


FIGURE 61. SOUTH FESCUE LMU DISTRIBUTION FOREST LANDBASED PATCH SIZE

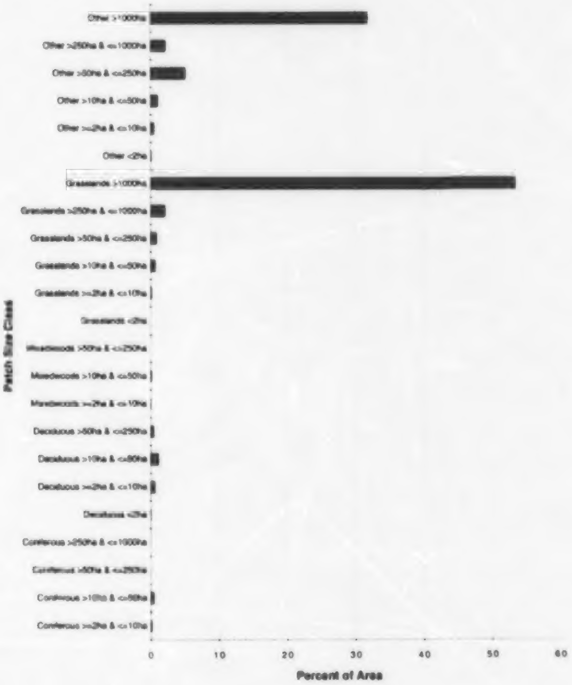


FIGURE 62. CROWSNEST PASS LMU DISTRIBUTION FOREST LANDBASED PATCH SIZE

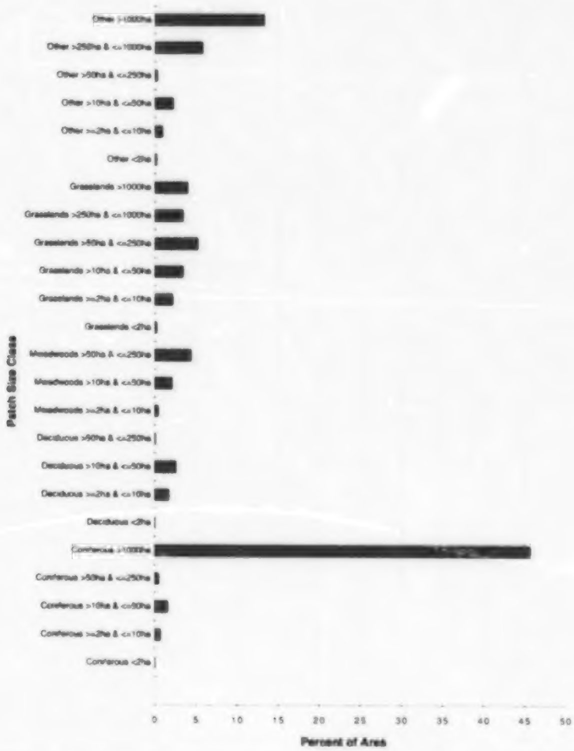


FIGURE 63. IRONSTONE LMU DISTRIBUTION FOREST LANDBASED PATCH SIZE

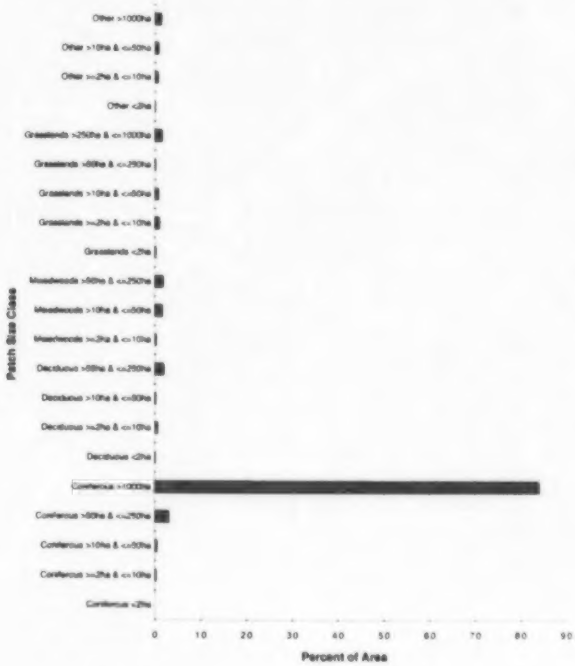


FIGURE 64. SOUTH LIVINGSTONE LMU DISTRIBUTION FOREST LANDBASED PATCH SIZE

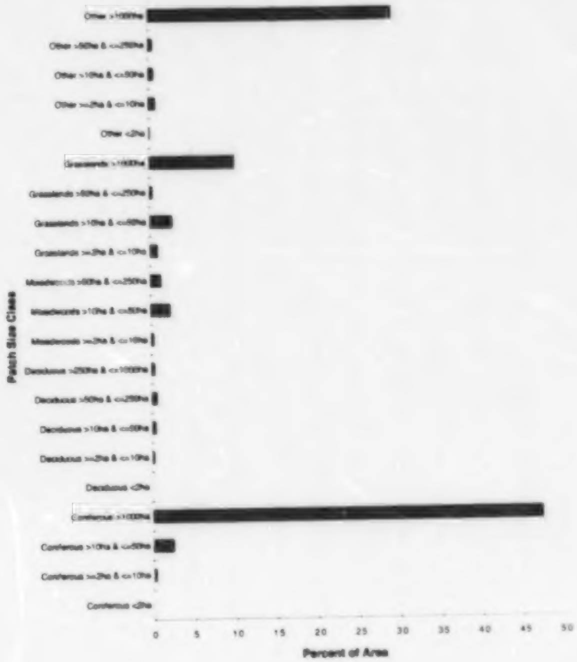


FIGURE 65. WHALEBACK LMU DISTRIBUTION FOREST LANDBASED PATCH SIZE

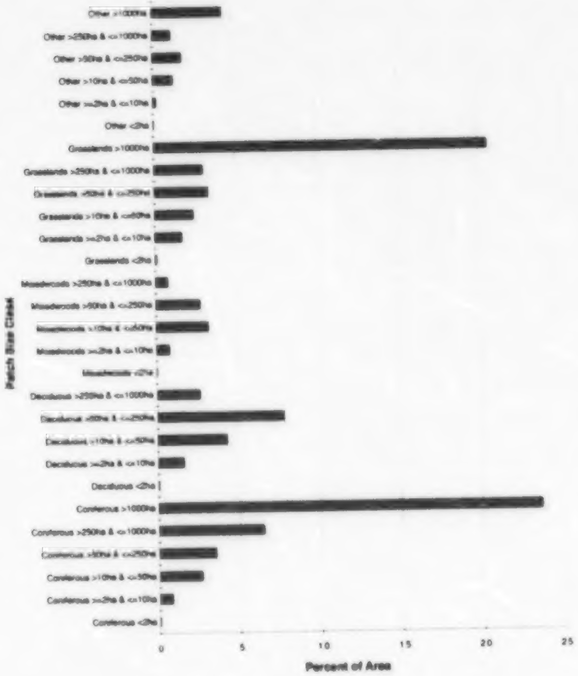


FIGURE 66. HORSESHOE PARKLAND LMU DISTRIBUTION FOREST LANDBASED PATCH SIZE

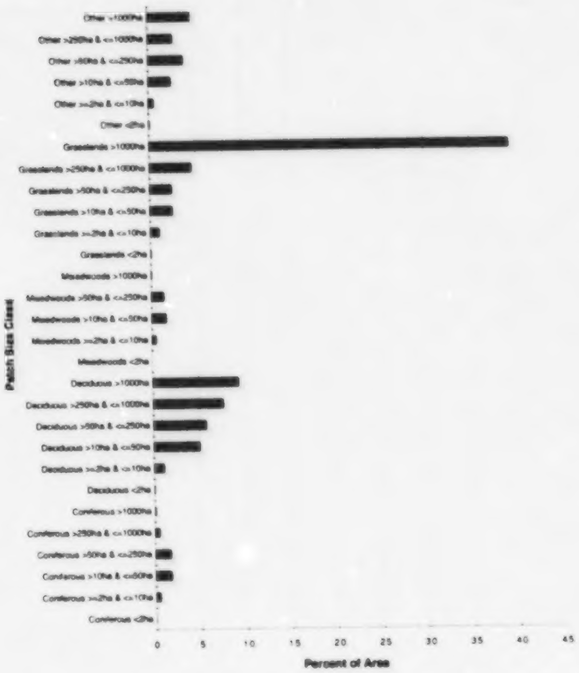
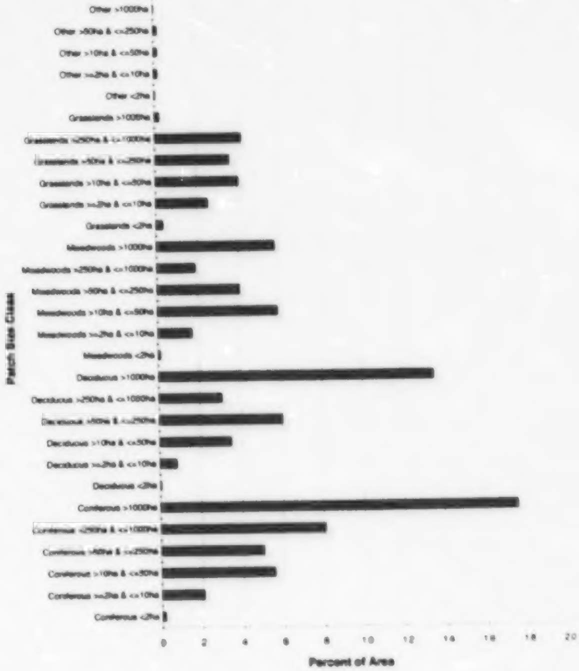


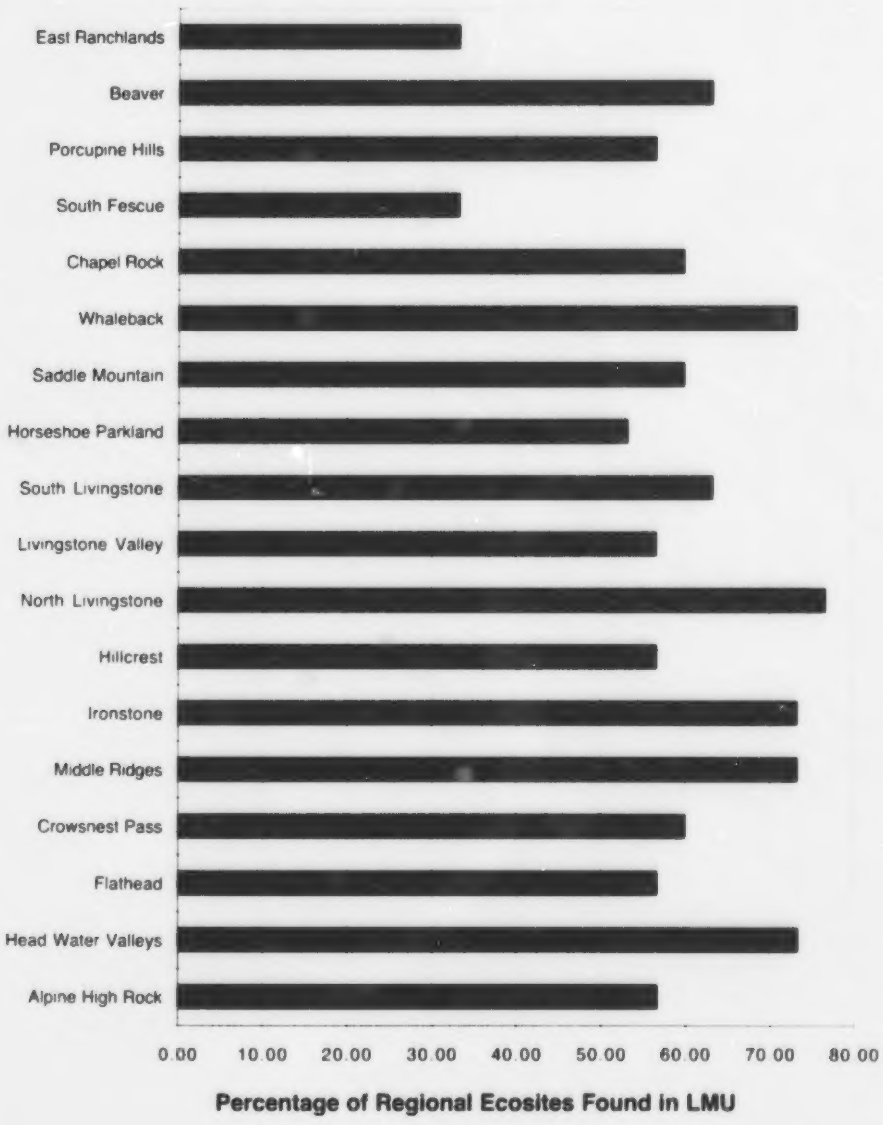
FIGURE 67. SADDLE MOUNTAIN LMU DISTRIBUTION FOREST LANDBASED PATCH SIZE



3.3 ECOSITE

The area was classified into ecosites by the methods previously mentioned. The distribution of ecosites by landscape management unit is found in Appendix 3. The number and distribution of ecosites is expected to be unchanging over time unless there is extreme site disturbance and soil destruction. The North Livingstone, Middle Ridges, Head Water Valleys, Ironstone and Whaleback LMUs all have relatively high richness ratings in terms of the percentage of ecosites found in the region that are found in the LMU. This could be expected to correlate with potential biodiversity although this is untested in the area.

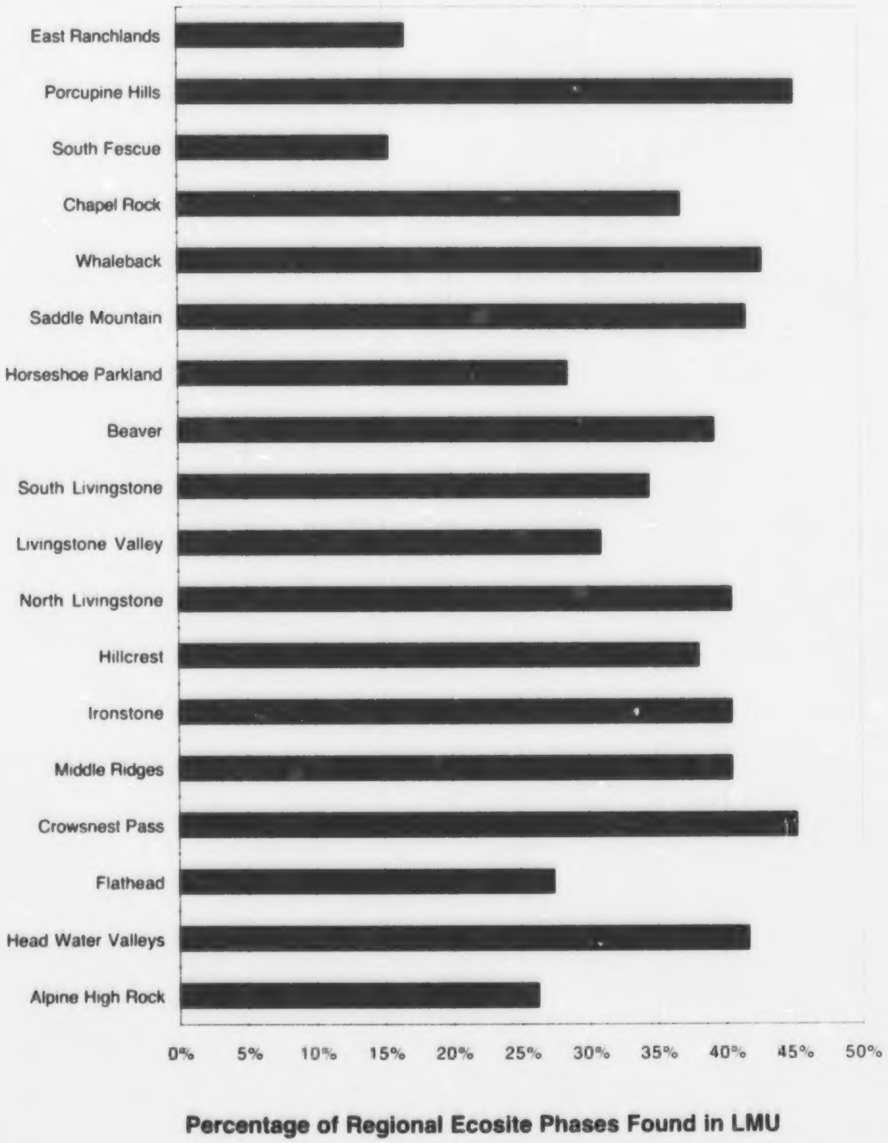
FIGURE 68. RELATIVE RICHNESS OF ECOSITES BY LMU



3.4 ECOSITE PHASE (BY MATURITY CLASS)

As ecosite phase by maturity class is the basis of the language of the future alternatives, it is important to provide a baseline of current conditions with which to compare the scenarios. Details of the characteristics (composition, size classes, etc.) of individual LMUs are listed in Appendix 7. Relative richness of both ecosite phase and ecosite phase by maturity class are displayed in the following charts. The Porcupine Hills, Crowsnest Pass, Whaleback, Saddle Mountain (all montane areas) and the Head Water Valleys were the top five in terms of ecosite phase richness.

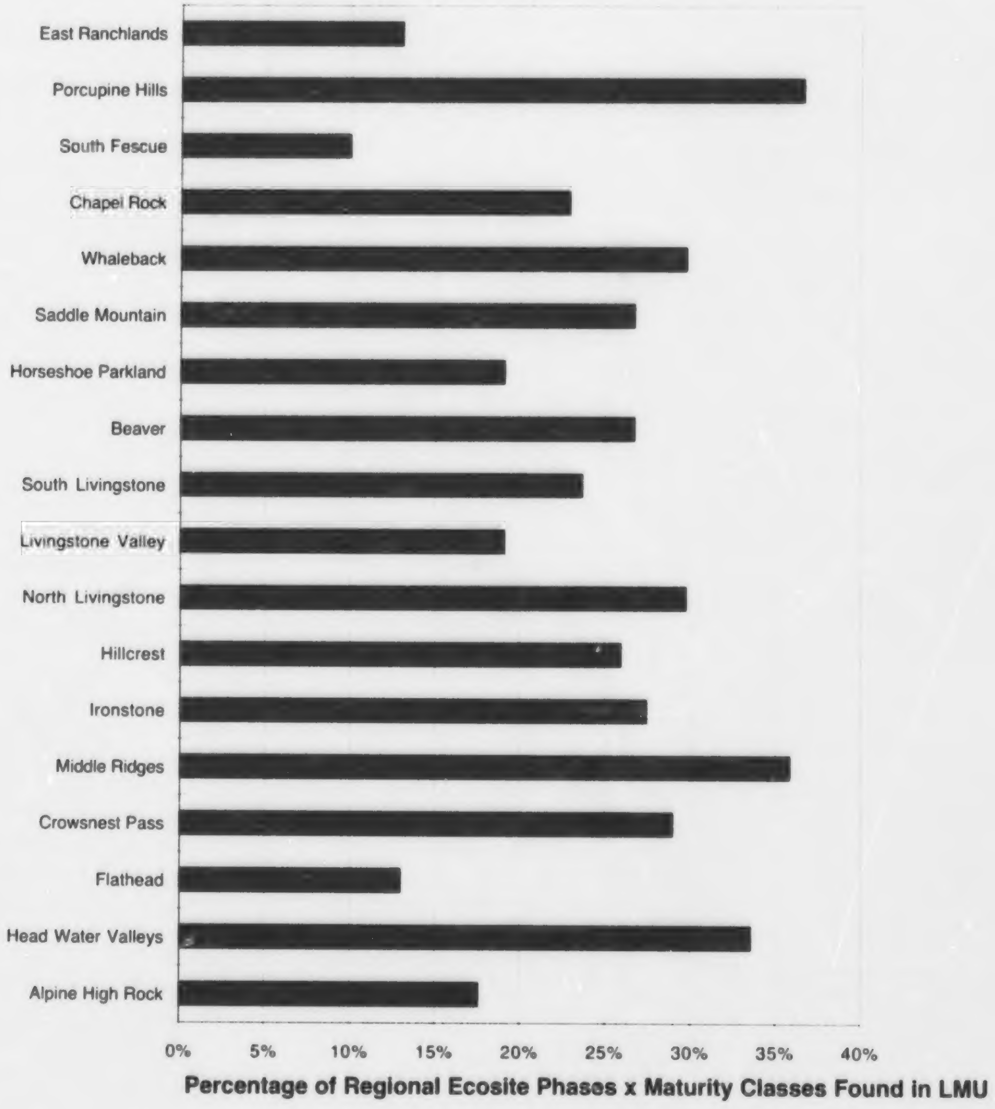
FIGURE 69. RELATIVE RICHNESS OF ECOSITE PHASES BY LMU



3.5 ECOSITE PHASE DIVERSITY

A map of ecosite phase diversity was created by focal scanning within a 1 kilometer moving circular window for the number of different ecosite phases. The map indicates "hotspots" of potential biodiversity and clearly indicates that the Whaleback, Saddle Mountain, North Livingstone and Horseshoe Parkland LMUs have the highest potential diversity in the region. Saddle Mountain is the highest of these. All of the hotspots are on landscape boundaries (ecotones).

FIGURE 70. RELATIVE RICHNESS OF ECOSITE PHASES BY MATURITY CLASS BY LMU



3.6 EDGES / BOUNDARY CONDITIONS

Amount and type of edge or boundary characteristics are an important measure of landscape structure and affect many ecological processes. A map was prepared which indicates the various combinations of adjacency conditions. The map was created by spreading (one class at a time) one cell (25 m) from the coniferous, deciduous, mixedwoods, grassland classes of the Forest Landbase map into the rest of the classes on the same map. The amounts of each edge type were accumulated for the region. Input map patch cell resolution was 25 m.

The following table indicates, by cover class, the types of adjacency conditions that exist in the study area. As an example, there are approximately 2200 km of coniferous edge (within the coniferous patch) that is adjacent (within 25 m) to deciduous forest while there are approximately 96 km of coniferous edge that is adjacent to both deciduous forest and grassland. The ecological implications of these adjacency conditions are not well understood, but are the subject of current research in the study area (Hersperger, 1998). That research is investigating the effects of various configurations of patches and results should be published by 2001.

TABLE 16. EDGE CONDITIONS BY FOREST LANDBASE CLASSIFICATION (CONIFEROUS, DECIDUOUS, MIXEDWOOD, GRASSLAND, OTHER)

CONIFEROUS PATCHES

Class Name	Cell Count	% of Class	Hectares	Length km
CONIFEROUS Interior (Assuming 25 m edge)	2,473,773.00	82.64	154,610.81	
deciduous	87,999.00	2.94	5499.94	2199.98
mixedwood	92,451.00	3.09	5778.19	2311.28
deciduous/mixedwood	1984.00	0.07	124.00	49.60
grassland	265,951.00	8.88	16,621.94	6648.78
deciduous/grassland	3843.00	0.13	240.19	96.08
mixedwood/grassland	3056.00	0.10	191.00	76.40
deciduous/mixedwood/grassland	32.00	0.00	2.00	0.80
other	61,101.00	2.04	3818.81	1527.53
deciduous/other	516.00	0.02	32.25	12.90
mixedwood/other	374.00	0.01	23.38	9.35
deciduous/mixedwood/other	6.00	0.00	0.38	0.15
grassland/other	2206.00	0.07	137.88	55.15
deciduous/grassland/other	17.00	0.00	1.06	0.43
mixedwood/grassland/other	9.00	0.00	0.56	0.23
Total	**2,993,318.00**	**100.00**	**187,082.38**	**12,988.63**

DECIDUOUS PATCHES

Class Name	Cell Count	% of Class	Hectares	Length km
DECIDUOUS Interior (Assuming 25 m edge)	511,085.00	61.60	31,942.81	
coniferous	84,237.00	10.15	5264.81	2105.93
mixedwood	32,724.00	3.94	2045.25	818.10
coniferous/mixedwood	2176.00	0.26	136.00	54.40
grassland	160,433.00	19.34	10,027.06	4010.83
coniferous/grassland	5657.00	0.68	353.56	141.43
mixedwood/grassland	2366.00	0.29	147.88	59.15
coniferous/mixedwood/grassland	49.00	0.01	3.06	1.23
other	27,651.00	3.33	1728.19	691.28
coniferous/other	723.00	0.09	45.19	18.08
mixedwood/other	251.00	0.03	15.69	6.28
coniferous/mixedwood/other	3.00	0.00	0.19	0.08
grassland/other	2333.00	0.28	145.81	58.33
coniferous/grassland/other	15.00	0.00	0.94	0.38
mixedwood/grassland/other	6.00	0.00	0.38	0.15
Total	**829,709.00**	**100.00**	**51,856.81**	**7965.60**

MIXEDWOOD PATCHES

Class Name	Cell Count	% of Class	Hectares	Length km
MIXEDWOODS Interior (Assuming 25 m edge)	230,443.00	55.36	14,402.69	
coniferous	87,707.00	21.07	5481.69	2192.68
deciduous	32,731.00	7.86	2045.69	818.28
coniferous/deciduous	1909.00	0.46	119.31	47.73
grassland	48,495.00	11.65	3030.94	1212.38
coniferous/grassland	3738.00	0.90	233.63	93.45
deciduous/grassland	2006.00	0.48	125.38	50.15
coniferous/deciduous/grassland	44.00	0.01	2.75	1.10
other	7916.00	1.90	494.75	197.90
coniferous/other	437.00	0.10	27.31	10.93
deciduous/other	297.00	0.07	18.56	7.43
coniferous/deciduous/other	5.00	0.00	0.31	0.13
grassland/other	478.00	0.11	29.88	11.95
coniferous/grassland/other	14.00	0.00	0.88	0.35
deciduous/grassland/other	8.00	0.00	0.50	0.20
Total	**416,228.00**	**100.00**	**26,014.25**	**4644.63**

GRASSLAND PATCHES

Class Name	Cell Count	% of Class	Hectares	Length km
GRASSLANDS Interior (Assuming 25 m edge)	2,172,616.00	78.89	135,788.50	
coniferous	242,557.00	8.81	15,159.81	6063.93
deciduous	163,266.00	5.93	10,204.13	4081.65
coniferous/deciduous	4561.00	0.17	285.06	114.03
mixedwood	48,963.00	1.78	3060.19	1224.08
coniferous/mixedwood	3559.00	0.13	222.44	88.98
deciduous/mixedwood	2327.00	0.08	145.44	58.18
coniferous/deciduous/mixedwood	53.00	0.00	3.31	1.33
other	110,977.00	4.03	6936.06	2774.43
coniferous/other	2238.00	0.08	139.88	55.95
deciduous/other	2378.00	0.09	148.63	59.45
coniferous/deciduous/other	15.00	0.00	0.94	0.38
mixedwood/other	402.00	0.01	25.13	10.05
coniferous/mixedwood/other	11.00	0.00	0.69	0.28
deciduous/mixedwood/other	4.00	0.00	0.25	0.10
coniferous/deciduous/mixedwood/other	1.00	0.00	0.06	0.03
Total	**2,753,928.00**	**100.00**	**172,120.50**	**14,532.80**

OTHER PATCHES

Class Name	Cell Count	% of Class	Hectares	Length km
OTHER Interior (Assuming 25 m edge)	673,098.00	76.49	42,068.63	
coniferous	56,523.00	6.42	3532.69	1413.08
deciduous	28,445.00	3.23	1777.81	711.13
coniferous/deciduous	628.00	0.07	39.25	15.70
mixedwood	7995.00	0.91	499.69	199.88
coniferous/mixedwood	548.00	0.06	34.25	13.70
deciduous/mixedwood	338.00	0.04	21.13	8.45
coniferous/deciduous/mixedwood	2.00	0.00	0.13	0.05
grassland	107,966.00	12.27	6747.88	2699.15
coniferous/grassland	1903.00	0.22	118.94	47.58
deciduous/grassland	2124.00	0.24	132.75	53.10
coniferous/deciduous/grassland	17.00	0.00	1.06	0.43
mixedwood/grassland	419.00	0.05	26.19	10.48
coniferous/mixedwood/grassland	10.00	0.00	0.63	0.25
deciduous/mixedwood/grassland	11.00	0.00	0.69	0.28
coniferous/deciduous/mixedwood/grassland	1.00	0.00	0.06	0.03
Total	**880,028.00**	**100.00**	**55,001.75**	**5173.25**

Additional edge analysis is included in the following section.

3.7 OTHER LANDSCAPE METRICS

The number of landscape metrics that are now available to quantitatively describe the landscape is daunting indeed. There are literally dozens of ways to describe the landscape, most of which have **not** been correlated with any local ecological conditions or processes. The importance of maintaining large patches has been well documented (Forman, 1995 and others) as has the importance of preserving patch interiors (cores) and their associated species. The relevance of patch diversity indices is dependent upon the patch definition used to classify the input map.

Two methods for patch classification have been used in the analysis. The first classifies patches as coniferous, deciduous, mixedwood, grassland or other (after the forest landbase map classification) and the second classifies patches by ecosite phase. Indices for the first were calculated for both the regional as a whole, aggregating the results for all classes, as well as for the five classes.

The analysis was carried out using FRAGSTATS spatial pattern analysis software (McGarigal et. al., 1994). Indices were reported for both the region as a whole, aggregating the results for all classes, as well as for the five individual classes. For details of the methodology and algorithms used in the analysis, readers are referred to the FRAGSTATS documentation. Most of the metrics remain to be correlated with ecological criteria, but have been included as baseline measurements of the existing conditions.

TABLE 17. REGIONAL STRUCTURAL INDICES OF ALL FOREST LANDBASE CLASSES (CONIFEROUS, DECIDUOUS, MIXEDWOOD AND GRASSLAND PATCHES)

Area Weighted Mean Patch Fractal Dimension	1.17
Area Weighted Mean Shape Index	23.00
Core Area Coefficient of Variation 1 (%)	3933.13
Core Area Coefficient of Variation 2 (%)	2350.52
Core Area Density (#/100 ha)	1.30
Core Area Standard Deviation 1 (ha)	1040.00
Core Area Standard Deviation 2 (ha)	846.90
Double Log Fractal Dimension	-21.70
Edge Density (m/ha)	54.21
Frequency	7991.00
LCAS	48.32
Largest Patch Index (%)	26.49
Landscape Shape Index	101.13
Mean Core Area 1 (ha)	26.44
Mean Core Area 2 (ha)	37.25
Mean Core Index (%)	2.40
Mean Nearest Neighbour	117.04
Mean Patch Fractal Dimension	1.39
Mean Patch Size (ha)	54.72
Mean Shape Index	2.27
Modified Simpson's Diversity Index	1.03
Modified Simpson's Evenness Index	0.75
Number of Core Areas	5673.00
Nearest Neighbour Coefficient of Variation (%)	194.42
Nearest Neighbour Standard Deviation (m)	227.54
Nearest Neighbour Number of Patches	1575.00
Number of Patches	7991.00
Patch Density (#/100 ha)	1.83
PLAND	100.00
Patch Richness	4.00
Patch Richness Density (#/100 ha)	0.00
Patch Size Coefficient of Variation (%)	2843.44

Patch Size Standard Deviation (ha)	1555.99
Relative Patch Richness (%)	100.00
Shannon's Diversity Index	1.15
Shannon's Evenness Index	0.83
Simpson's Diversity Index	0.64
Simpson's Evenness Index	0.86
STD—Area (ha)	1555.99
STD—Core	1040.00
STD—Core Area (ha)	846.90
Total Area (ha)	437,282.09
Total Core Area (ha)	211,296.86
Total Core Area Index (%)	48.32
Total Edge (km)	23,706.48

3.7.1. REGIONAL LANDSCAPE METRICS

Table 17 indicates that while there are 7991 patches using this classification, only 5673 had core areas (those areas that remain after 100 m edge removal). Mean patch size is 54.72 ha and edge density averages 54.21 m/ha. These indices deserve to be tracked in future landscape. The usefulness of the diversity and richness indices on this level of aggregation of patches is highly questionable.

The following table indicates the landscape metrics for individual forest landbase classes. There are important variations between the classes that are not evident in the aggregated analysis. Most notably is patch size, shape, core area, percent of landscape and number of cores versus number of patches. Coniferous areas tend to be much larger with a greater percentage of interior patch cores than other classes.

TABLE 18. REGIONAL STRUCTURAL INDICES BY FOREST LANDBASE CLASSES

Class/Type	**CONIFEROUS**	**DECIDUOUS**	**MIXEDWOODS**	**GRASSLANDS**
Area Weighted Mean Patch Fractal Dimension	1.39	1.25	1.33	1.29
Area Weighted Mean Shape Index	33.98	8.47	4.29	18.73
Class Area (ha)	187,802.36	51,823.60	26,056.84	171,599.30
Patch Core Area Coefficient of Variation (%)	2854.61	1194.46	615.35	3308.54
Disjunct Core Area Coefficient of Variation (%)	1953.89	431.21	312.31	2028.85
Core Area Density (#/100 ha)	0.35	0.33	0.19	0.44
Patch Core Area Standard Deviation (ha)	1948.47	69.36	15.47	889.77
Disjunct Core Area Standard Deviation (ha)	1381.01	31.72	12.03	960.05
Core Area Percent of Landscape (%)	24.59	2.40	0.72	20.62
Number of Patches per Class	1575.00	1805.00	1259.00	3352.00
Largest Patch Index (%)	26.49	1.54	0.38	15.51
Mean Core Area per Patch 1 (ha)	68.26	5.81	2.51	26.89
Mean Area per Disjunct Core (ha)	70.68	7.36	3.85	47.32
Mean Core Area Index (%)	2.99	2.60	3.10	1.76
Mean Patch Fractal Dimension	1.39	1.38	1.38	1.39
Mean Patch Size (ha)	119.24	28.71	20.70	51.19
Mean Shape Index	2.13	2.40	2.46	2.20
Number of Core Areas	1521.00	1425.00	822.00	1905.00
Number of Patches	1575.00	1805.00	1259.00	3352.00
Patch Density (#/100 ha)	0.36	0.41	0.29	0.77
Percent of Landscape (%)	42.95	11.85	5.96	39.24
Patch Size Coefficient of Variation (%)	2482.81	680.79	272.01	2495.02
Patch Size Standard Deviation (ha)	2960.51	195.46	56.30	1277.28
Total Core Area (ha)	107,504.48	10,482.40	3165.19	90,144.79
Total Core Area Index (%)	57.24	20.23	12.15	52.53

3.7.2 METRICS OF LANDSCAPE MANAGEMENT UNITS

The following indices were calculated for the three landscape management units in which forest harvesting is most likely to occur in the near future. Calculations are provided for all other LMUs in Appendix 8. The analysis was carried using FRAGSTATS on an input map of ecosite phase.

TABLE 19. LANDSCAPE INDICES BY LMU (PATCH DEFINITION BASED ON ECOSITE PHASE)

INDICES	Head Water Valleys	Middle Ridges	Porcupine Hills
Area Weighted Mean Patch Fractal Dimension	1.19	0.91	0.93
Area Weighted Mean Shape Index	5.02	4.58	6.49
Core Area Coefficient of Variation 1 (%)	2105.72	3204.34	4199.23
Core Area Coefficient of Variation 2 (%)	477.02	383.53	416.41
Core Area Density (#/100 ha)	2.08	2.00	2.09
Core Area Standard Deviation 1 (ha)	26.87	12.56	10.92
Core Area Standard Deviation 2 (ha)	54.40	30.47	24.96
Double Log Fractal Dimension	18.81	−22.84	−23.10
Edge Density (m/ha)	92.59	130.04	145.73
Largest Patch Index (%)	8.12	4.33	3.99
Landscape Shape Index	47.69	98.13	114.30
Max—Area (ha)	2707.88	3099.06	3082.75
Mean Core Area 1 (ha)	1.28	0.39	0.26
Mean Core Area 2 (ha)	11.41	7.94	5.99
Mean Core Index (%)	0.60	0.21	0.16
Mean Patch Fractal Dimension	1.40	1.41	1.42
Mean Patch Size (ha)	5.37	2.47	2.08
Mean Shape Index	1.53	1.45	1.42
Modified Simpson's Diversity Index	1.71	1.73	1.72
Modified Simpson's Eveness Index	0.48	0.48	0.48
Number of Core Areas	695.00	1429.00	1612.00
Number of Patches	6211.00	28,984.00	37,206.00
Patch Density (#/100 ha)	18.63	40.50	48.13
Patch Richness	35.00	37.00	36.00
Patch Richness Density (#/100 ha)	0.11	0.05	0.05
Patch Size Coefficient of Variation (%)	1079.99	1357.92	1524.50
Patch Size Standard Deviation (ha)	57.97	33.53	31.68
Relative Patch Richness (%)	94.60	100.00	97.30
Shannon's Diversity Index	2.09	2.29	2.02
Shannon's Eveness Index	0.59	0.63	0.56
Simpson's Diversity Index	0.82	0.82	0.82
Simpson's Eveness Index	0.84	0.85	0.84
Total Area (ha)	33,341.81	71,555.22	77,296.81
Total Core Area (ha)	7926.29	11,352.51	9662.45
Total Core Area Index (%)	23.77	15.87	12.50
Total Edge (km)	3087.05	9305.48	11,265.22

The results of the analysis indicate very different conditions within the three landscapes. Both the Middle Ridges and the Head Water Valleys are subalpine landscapes while the Porcupine Hills is montane. Edge density is highest in the Porcupine Hills and lowest in the Head Water Valleys. Mean patch size is indicated at 5.37 ha for the Head Water Valleys with a total core area index of 23.77% (indicating the percentage of patches with cores or interiors). Patch density is by far the highest in the Porcupine Hills.

3.8 GENERALIZED LANDSCAPE PATTERN

Landscape ecology focuses on the spatial relationships between the structural and functional elements of the land. Research in the fields of landscape ecology, conservation biology, forestry and others indicates that spatial pattern plays an essential role in natural processes. (Harris 1984, Franklin 1993, Soule 1987, Mefe and Carroll 1994). The underlying hypothesis used in the evaluation of landscape ecological pattern is that there are certain essential or indispensible patterns that will conserve the majority of important ecological functions. While all or specific attributes of an ecosystem will not be protected by these measures, the most important will retain their integrity if the essential general patterns are maintained.

The patch—matrix—corridor model as described by Forman and Godron (1986) may be applied to any landscape at any scale. A landscape may be considered as a mosaic of the background matrix and patches connected by corridors. Forman (1995) suggests that the following are indispensible to providing an ecologically viable landscape:

1) Large patches of natural vegetation which provide the benefits of species richness and habitat for interior species.

2) Connectivity between large patches in the form of wide corridors or clusters of smaller patches of natural vegetation. At least some of these corridors or clusters of patches should be large enough to provide interior habitat.

3) Vegetated corridors along major streams and rivers to provide for species movement, erosion control and protection of fish habitat. In addition, headwater seepage areas and first order streams should receive protection in the form of near contiguous vegetative cover.

4) Stepping stones of small natural vegetation patches through altered landscapes to provide for such benefits as rare species habitats and species movement.

A map of elements of a generalized landscape pattern was created in order to assess the provision of some of these indispensible patterns. Vegetation patches were classed as either natural or anthropomorphic, making no distinction between forested or non forested lands. Natural vegetation patches were bisected or "fractured" by "shear forces" such as large streams and rivers, human settlement, recent clearcuts, etc. The connectivity of the existing naturally vegetated landscape is measured by the amount of land in large connected patches.

The map includes the following classes:

Contiguous Natural Vegetation (the matrix) — Natural Vegetation Patches greater than 1000 ha (created by dissecting natural vegetation with shear forces — see below).

Isolated Natural Vegetation — Natural Vegetation Patches under 1000 ha.

Shear Forces — fourth order and greater streams, lakes and ponds, barren rock, perennial forage, arable agriculture, human settlements, railroads, access type A & B, major transmission lines, pipelines and recent clearcuts less than ten years old. These forces fragment the landscape.

Natural Edge — The 25 m within a patch of natural vegetation.

Vegetated Stream Corridors — natural vegetation within 25 m of a stream. Perennial forage or annual crops do not constitute natural vegetation and are therefore not included.

The resultant map, with its histogram, is a coarse summary of major landscape pattern conditions. The results indicate that the region is still largely composed of patches of natural vegetation over 1000 ha. However, several portions of the region, particularly in the Foothills Fescue LMU, Crowsnest Pass, Head Water Valleys and in the lower reaches of the Livingstone Valley as well as along Highway 22 and Willow Creek, are more highly fragmented and natural vegetation cover is more isolated.

Stream sides are well vegetated throughout most of the region. There are significant gaps in the natural vegetation connectivity of the riparian zones in the Crowsnest Pass and along the Oldman River and its tributaries through the Foothills Fescue LMU.

A large concentration of disturbed lands or those that act as "shear forces" or barriers in the landscape is found in the Crowsnest Pass. Highway #3 and the settlement areas of the Pass present a formidable barrier to many species. As development increases in the area and vegetation is converted or becomes more isolated, movement of many species both along the Crowsnest River Valley as well as north and south will become increasingly difficult.

The landscape mosaic of coniferous [illegible]
in the Whaleback LMU. The [illegible]
contributing significantly to the [illegible]

3.9 ANALYSIS BY NATURAL SUB REGIONS AND AGGREGATIONS OF LMUS

Regional and landscape management unit analysis has been the focus of much of this report. However, managers are often interested in broad pattern characterization at a level midway between these two scales. For that reason, limited analysis of both natural sub regions and aggregations of landscape management units with similar characteristics was undertaken. Disturbance patch size, age class and forest landbase cover class patch size analysis have been carried out.

3.9.1 NATURAL SUB REGIONS

Analysis on the natural sub regions has been limited to age class analysis and percentage coverage of the region. Some initial ecosite phase and forest landbase calculations were carried out, but the utility of the data was questionable. To date, the sub regions have been most useful in the delineation of landscapes (LMUs).

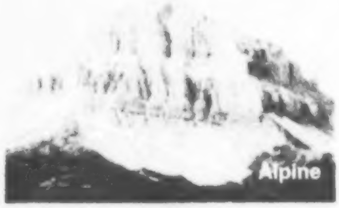
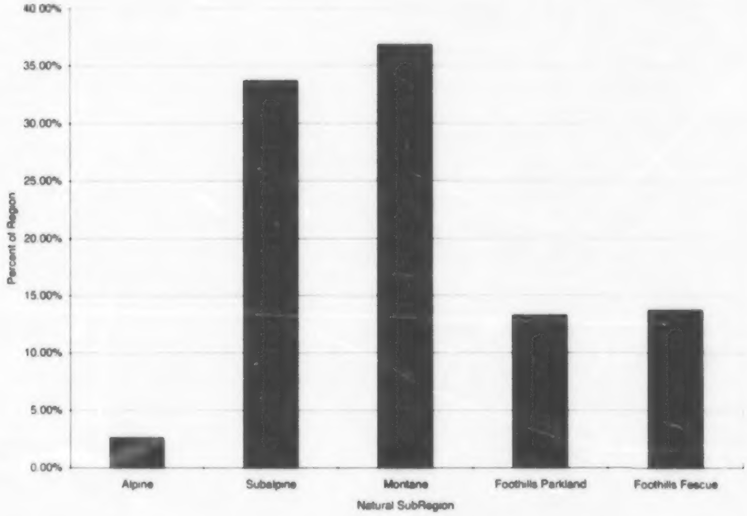
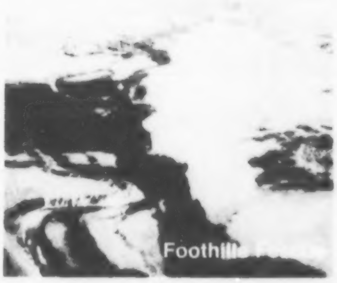


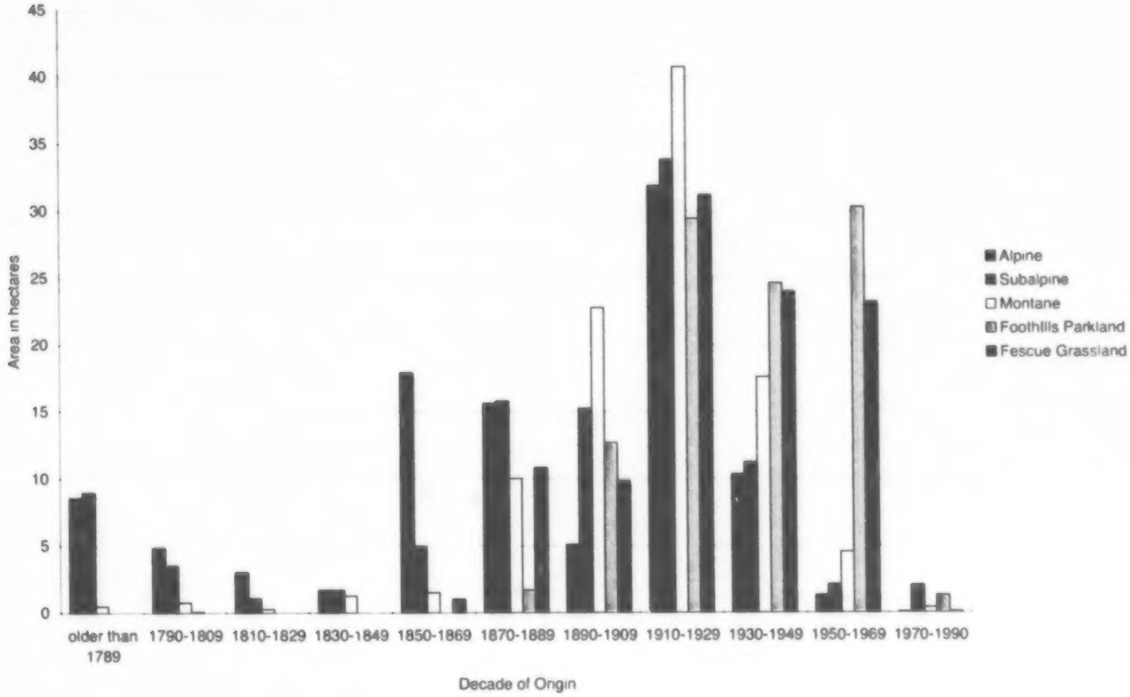
FIGURE 71. NATURAL SUB REGIONS – PERCENTAGE OF STUDY AREA





Foothills Parkland

FIGURE 72. STAND ORIGIN BY NATURAL SUB REGION



3.9.2 ANALYSIS BY AGGREGATIONS OF LANDSCAPE MANAGEMENT UNITS

The analysis of landbase cover type patch size by landscape management unit indicates considerable differences between LMUs. Despite these differences, there appear to be some geographic trends with certain LMUs having a higher diversity of patch types and a better representation of patch sizes. For purposes of understanding broad regional patterns beyond that of the landscape units, the following four aggregations of LMUs were made:

Alpine & Subalpine consists of the following LMUs: Alpine High Rock, Head Water Valleys, Flathead, Middle Ridges, Livingstone Valley, Ironstone, South Livingstone and Hillcrest. Little diversity in patch type or size was indicated. Coniferous forest is clearly the matrix with occasional patches of grassland. Age class analysis indicates that this is the area of old growth and greatest representation of age classes. Disturbance patch size is heavily weighted towards very large patches.

The Northern Montane and Parkland area consists of the following LMUs: North Livingstone, Saddle Mountain, Whaleback, Porcupine Hills and Horseshoe Parkland. The results display a more even distribution of areas in various patch types and sizes. While grassland is the background matrix of the area, coniferous is heavily interspersed. Deciduous and mixedwood forests are also extremely important components. Results from the breeding bird survey (Ursus 1997) indicate that this is the area of highest biodiversity in the larger study area (refer avian biodiversity map). Disturbance patch size is largely under 250 ha.

The **Southern Montane** consisting of the Crowsnest Pass, Chapel Rock and Beaver LMUs has a moderate diversity of patch types and sizes. Note that there are no coniferous patches between 250 and 100 ha. Much of this region lies in private hands and most of the larger (>1000 ha) coniferous patches are within the forest reserve. Grassland is the matrix in the area with deciduous forest patches providing an important component. Large grasslands predominate, but considerable areas have been converted to perennial forage crops. There are more larger disturbance patches than in the northern montane parkland. It also consists, by and large, of younger forests.

The **Foothills Fescue** area is dominated by natural grasslands over 1000 ha in size and perennial forage and annual crops. While the area remaining in natural grasslands is extensive, there has been considerable conversion to agronomic species and in some areas, cropland is now the matrix. Connectivity of grasslands is an emerging issue. Most of the deciduous forests are found in riparian zones or moist depressions.

FIGURE 73. DISTURBANCE PATCH SIZE BY AGGREGATED LANDSCAPE MANAGEMENT UNITS

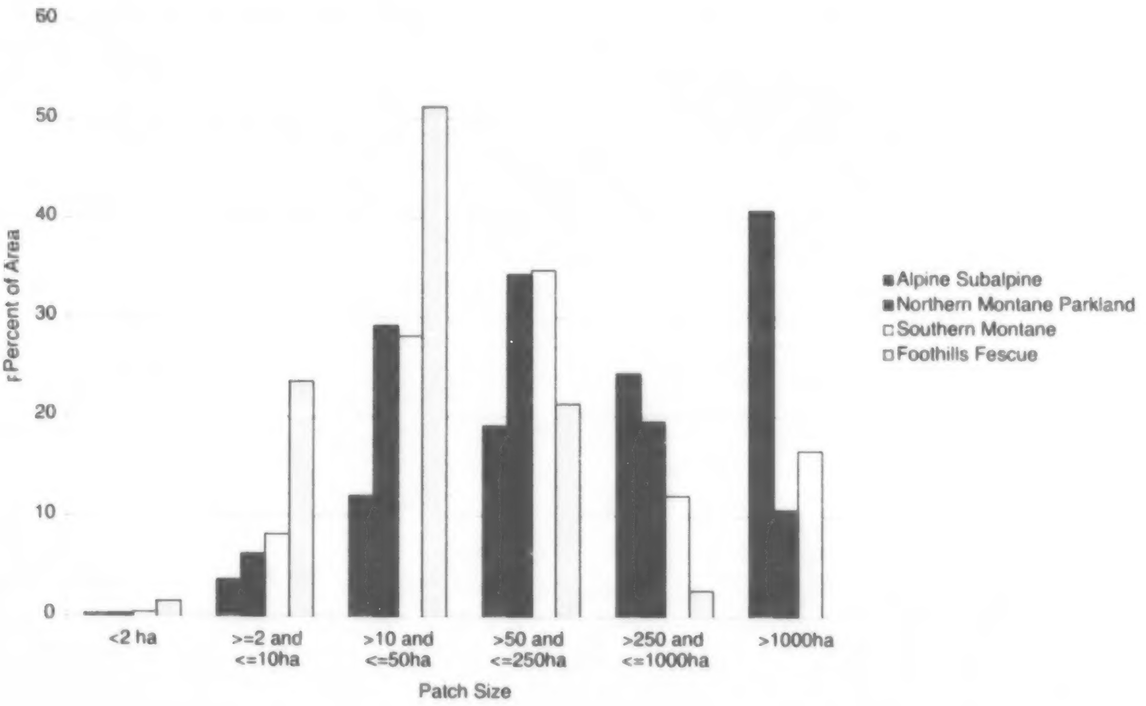


FIGURE 74. ALPINE & SUBALPINE LANDBASE COVER TYPE PATCH SIZE

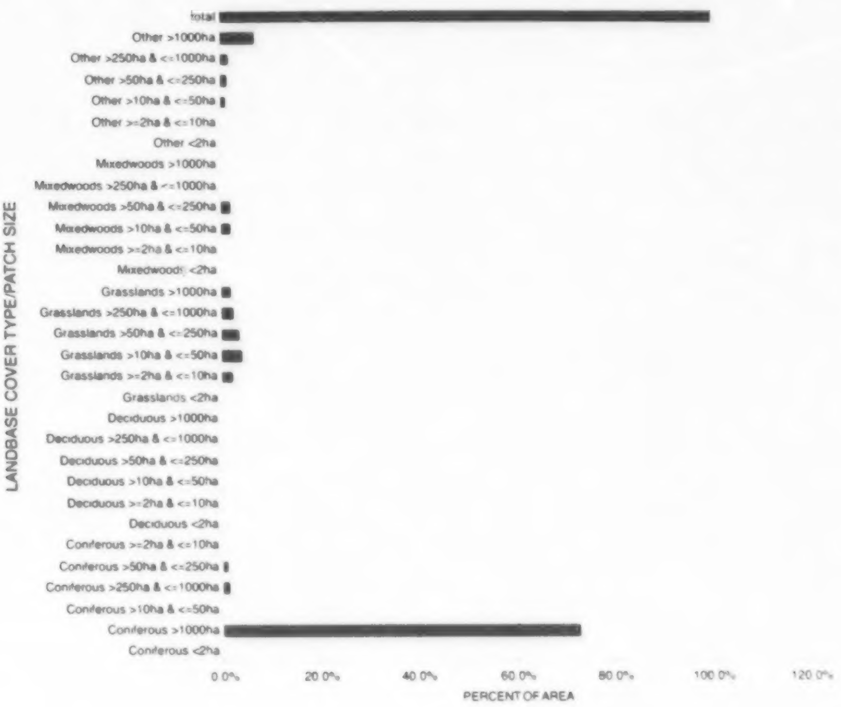


FIGURE 75. NORTHERN MONTANE AND PARKLAND LANDBASE COVER TYPE PATCH SIZE

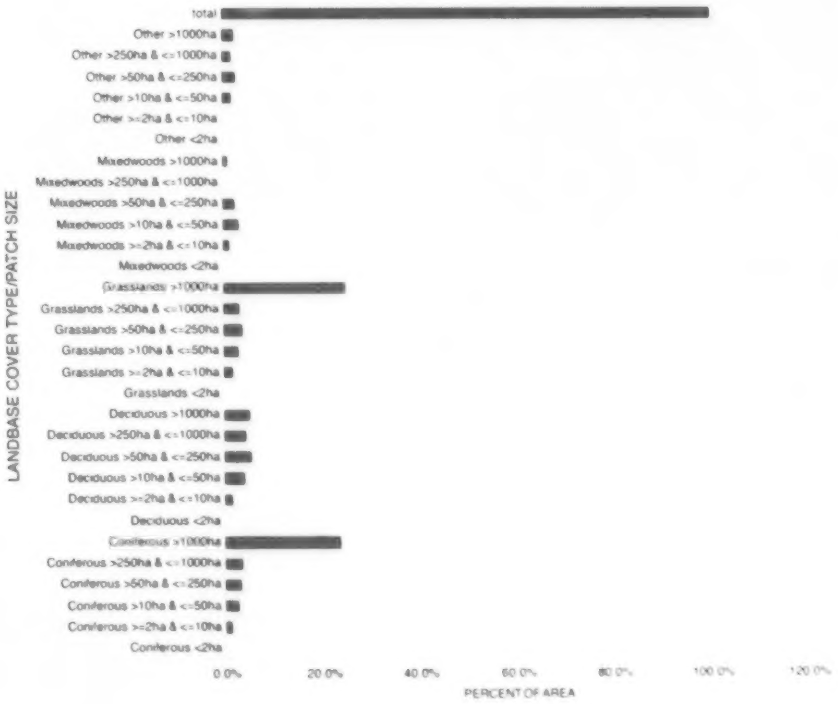


FIGURE 76. FOOTHILLS FESCUE LANDBASE COVER TYPE PATCH SIZE

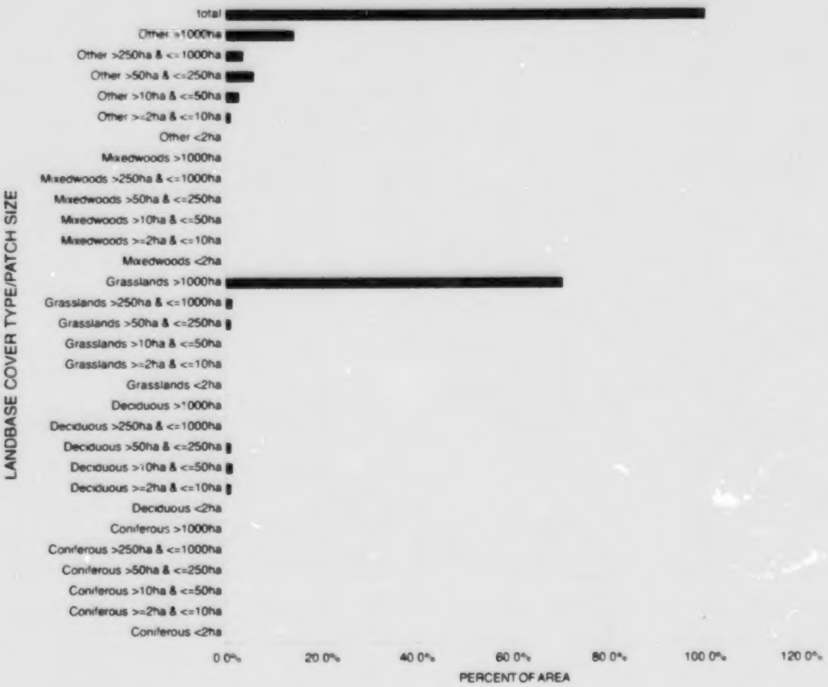


FIGURE 77. SOUTHERN MONTANE LANDBASE COVER TYPE PATCH SIZE

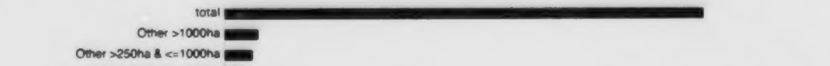
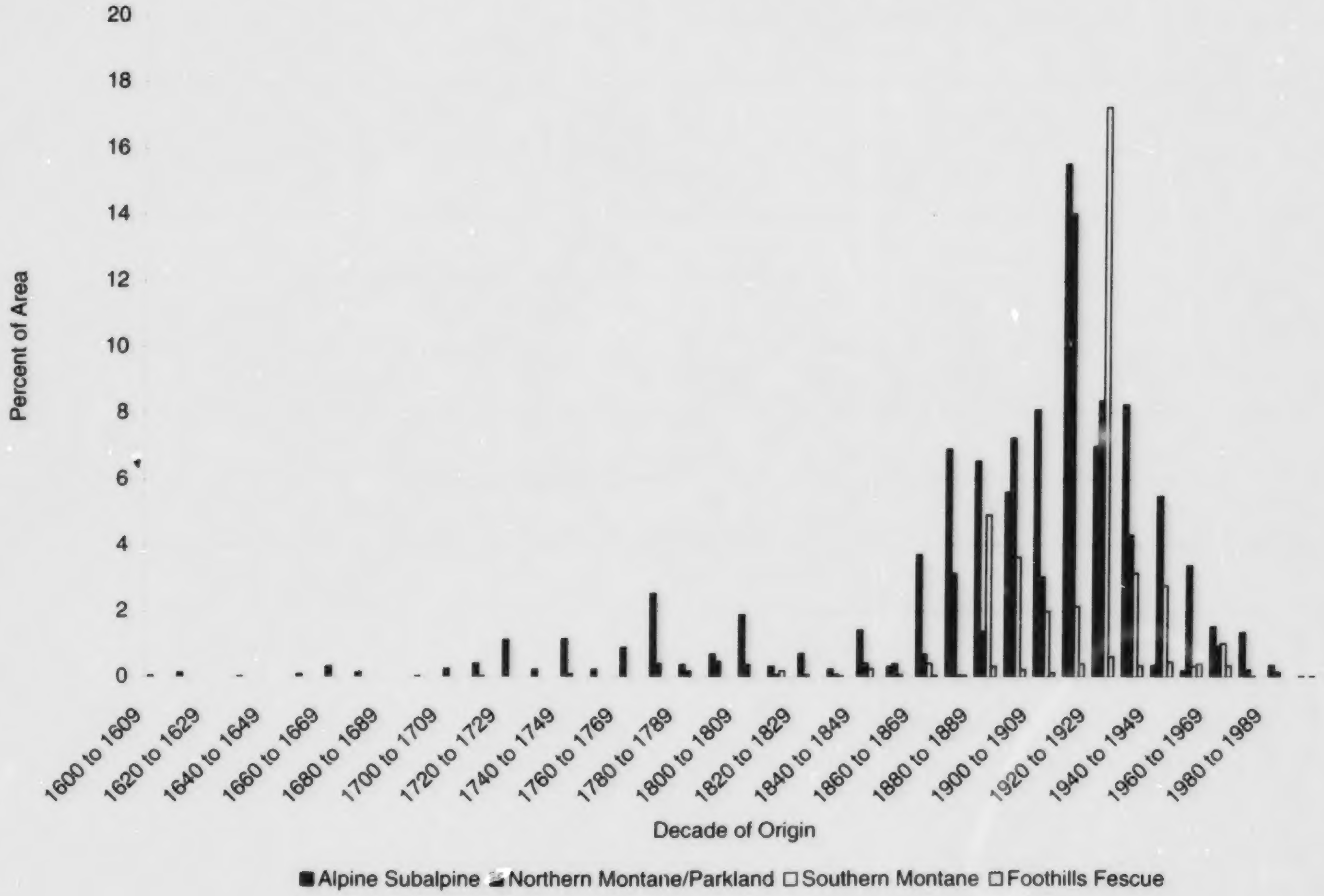


FIGURE 78. AGE CLASS BY AGGREGATED LANDSCAPE MANAGEMENT UNITS



4.0 IMPLICATIONS TO FOREST MANAGEMENT

The analysis of process and patterns in the study area has many implications for forest management. Climate, physiographic conditions, natural disturbance regimes and human interventions have significantly influenced the existing landscape patterns. As the current conditions are the departure point for the development of alternative future scenarios, forest managers must have a clear understanding of the processes that gave rise to the present day landscape. Desired future forests may or may not retain the existing structural characteristics. The decision to change regional patterns is essentially a societal value laden decision that is beyond the scope of this work. However, the risk and implications of diverting from the existing conditions must be fully understood. Landscape pattern objectives must be developed for both the region as a whole and for individual landscapes. The analysis clearly indicates that there are distinct differences between landscapes in terms of disturbance patch size distribution, age class distribution, vegetation cover and fuel types. Future management must acknowledge this variation.

One of the underlying tenets of ecosystem management is that, in the absence of certain knowledge about the implications of management options, it is prudent to manage within the range of variability already resident in the landscape. The structural characteristics that have been identified in this analysis, particularly disturbance patch size distribution, seral stage distribution, forest landbase cover class distribution, ecosite phase richness and extent, amount and type of edge and percent of patches with interior cores, should provide the default for future design criteria. These structural characteristics should be followed unless it can be clearly demonstrated that there are societal or ecological reasons for deviating from them (e.g. lessening of the risk of regional conflagrations, provision of increased economic benefit, improvement of wildlife habitat).

Design criteria based upon those listed above should be established for both individual landscapes and the entire region. For example, overall regional patch size distribution objectives may need to be achieved together with appropriate and variable distribution within LMUs. Both wildfire and harvesting patches will need to be used to calculate size class distribution.

The extreme variability (both temporally and spatially) in the decadal area of disturbance is strikingly apparent. This underlines the importance of using long time periods and large spatial scales to analyze disturbance regimes and land patterns. If short time periods are used for the temporal scale of analysis, few meaningful results can be obtained. In the study area, very large events occur periodically and are responsible for a large proportion of the total disturbance in the area. Equal annual areas of disturbance are simply not the regime in this region, as convenient as that would be for forest managers seeking an even flow of wood products from the forest landbase. Quite the opposite is the case; the inherent disturbance regime is very "spiky" in nature with vast amounts of disturbance occurring over a relatively short time period.

The "big bang" nature of the disturbance regime has enormous implications for forest management and forest protection. The overriding question that must be addressed is whether or not fire control can be effective enough, over the long—term, to allow for a sustainable forest industry harvesting large amounts of fibre while at the same time retaining an acceptable age class distribution for other uses. The importance of fire protection in reducing large fires and therefore increasing the amount available for extraction cannot be emphasized too strongly.

Reduction in fuel loads and fuel continuity may be required, particularly in those areas which contain the topography, fuels and potential ignition sources to produce very large fires (e.g. the Middle Ridges). The location of historical fires is instructive in this regard despite the obvious changes in historical fuel loads. Topography and climate in those areas still present the potential for very large fires. Current head fire intensity model mapping indicates areas of potential problems and where intensive fuel modification may be required.

Age class distribution will shift in the event of a set of large disturbances. The magnitude of these shifts may vary dramatically between landscape management units. Physiographic conditions, climate, potential fuel loads as well as ignition sources all determine the potential fire numbers and sizes as well as their impact on age class distribution. The analysis clearly indicates that there are differences in the disturbance regimes and resultant land patterns and age classes of landscapes. The Head Water Valleys for example should be managed very differently from the Porcupine Hills. Disturbance patch size is far larger in the former while at the same time there is a larger representation of old growth than in the Porcupine Hills. Managers should consider the current disturbance patch size and age class distribution and manage at least closer to the observed characteristics of individual landscape management units.

Forest management should respond to the differences between landscapes. Managers must, at the very least, be conscious of when they are varying from the disturbance size distribution that historically occurred. Harvest opening size distribution need not mimic those occurrences as the desired future forest pattern will be determined by many factors, not simply the inherent disturbance regime. However, managers need to be aware of the consequences of divergence from that regime.

As the age class distribution variability is so extreme in the area, snap shots of any point in time should not be used as management goals, but as general guidelines. These cannot be used as targets isolated from other issues. Rather, age class distribution should be managed for other reasons such as retention of a certain proportion of the area in older growth forest, timber product range, visual quality and biodiversity issues and others. Age classes should be well represented across the region, but these need not be in every landscape and the proportions can vary widely (as they do currently) and still be well within the natural range of variability.

It is acknowledged that there have been data limitations in this study, particularly with regard to the reliance on aerial photo interpretation for the stand origin data. There may be requirements for further work on the disturbance regime.

4.1 FOREST LANDSCAPE PATTERN, TRANSFORMATION AND POTENTIAL CUTBLOCK CONFIGURATION

The landscape pattern is largely determined by the type, size, shape and position of different patches of local ecosystems (i.e., individual stands). Other than fire, forestry operations are the major determinant of landscape pattern in the managed forest. Pattern must always be considered in the broader context and foresters must avoid consideration of individual patches in isolation of their overall configuration within the landscape or other sectoral objectives. Details of landscape pattern objectives that are specific to individual landscapes need to be developed. It is likely that these will include objectives relating to;

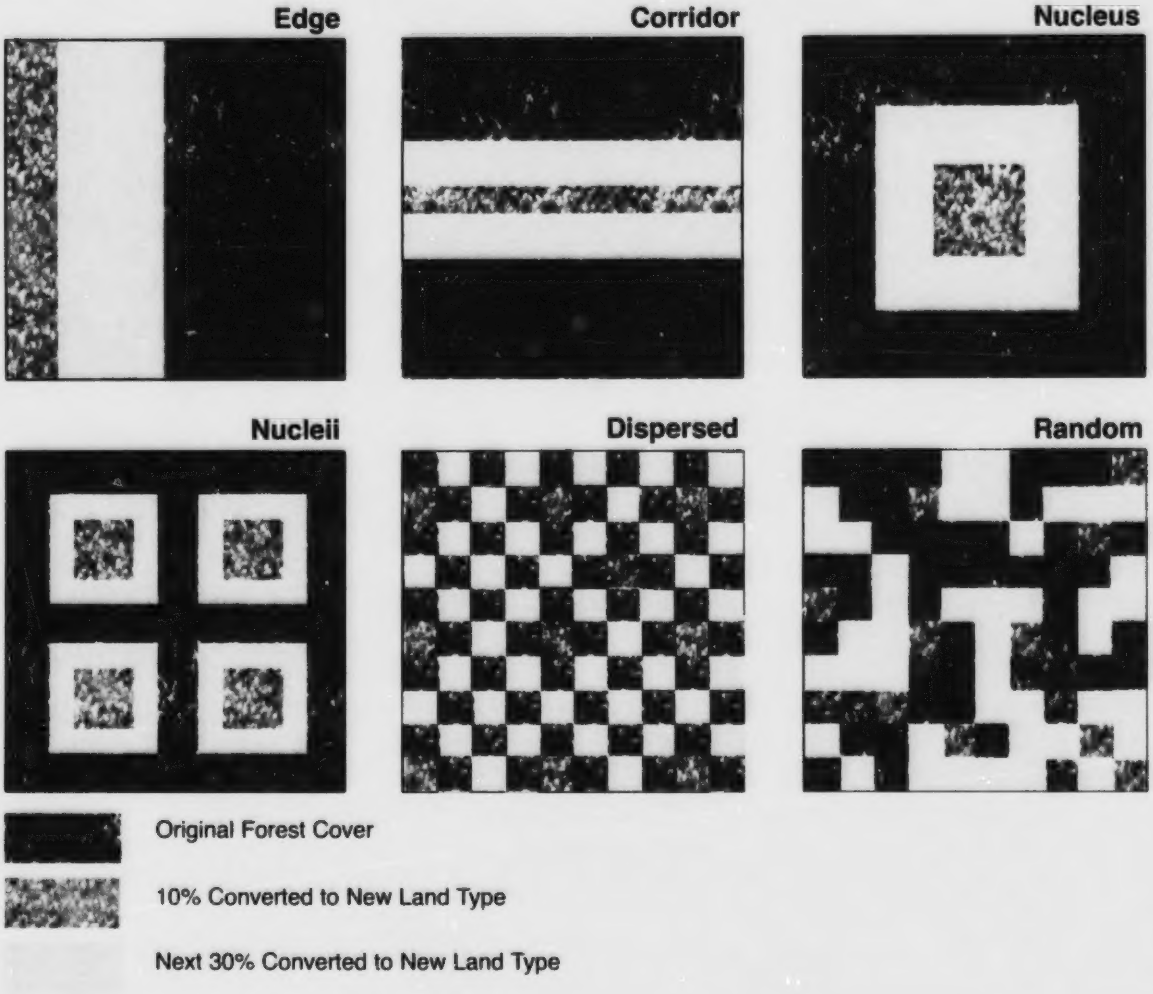
- age class distribution,
- patch size distribution (both opening size and regenerated patch size) — There is a great difference in

disturbance patch size and ecosite phase patch size. One large burn or opening may create many stands,

- ecosite phase diversity,
- retention of interior patch cores,
- connectivity including riparian connectivity,
- internal block structure,
- protection of unique or rare elements,
- visual quality,
- road location and accessibility, and
- wildlife habitat.

The key to this approach is the management of pattern and disturbance, not simply management for specific volumes of sectoral products. At the same time it is recognized that security of volume is an important business consideration.

FIGURE 79. CONCEPTUAL LAND TRANSFORMATION SEQUENCE MODELS (after Forman, 1995)


Edge
Corridor
Nucleus
Nucleii
Dispersed
Random
Original Forest Cover
10% Converted to New Land Type
Next 30% Converted to New Land Type

In order to achieve these objectives, there are several conceptual models of land transformation sequences that may be applied to forestry operations in the study area. Cutting of forested lands generally occurs in one of the following land transformation sequence models:

Edge — Cutting progressively from an edge.
Corridor — Cutting outward from a central cut strip.
Nucleus — Cutting outward from a central point.
Nuclei — Cutting outward from several points.
Dispersed — Cuts that avoid adjacent cuts until later in the rotation may be alternate patch.
Alternative Strip Cutting — Long strips are cut with adjacent strip cuts retained until later.

The conceptual sequences are illustrated above. These configurations accommodate, to a greater or lesser degree, what Forman (1995) has called indispensable priority components for whole landscapes.

He cites several "indispensables" which cannot be substituted by other components and are critical to a well functioning landscape. These include;

- a few large natural vegetation patches,
- wide well vegetated corridors protecting water courses,
- connectivity for movement of key species among large patches, and
- heterogeneous bits of natural vegetation scattered across the human transformed forest in the form of "stepping stone" islands and corridors.

As large patches and connectivity are key components, an important aspect of forest landscape management is to reduce the shrinkage, perforation, dissection and fragmentation of large well connected patches and to retain those components as long as possible. Of the transformation sequences listed, (edge, corridor, nucleus, nuclei, dispersed) the edge model maintains the largest patch for the longest period of time. This can be approximated with the progressive clearcut. However, certain aspects such as connectivity and stepping stones are not well addressed by the edge model.

The transformation sequence has important implications if forest logging operations are to approximate the extent of large natural disturbances. Currently, logging practices are of the **dispersed model** while fires in the area were of the **aggregated nucleus or multi nuclei model**. Currently, the most common logging practice is alternate patch clearcutting of relatively small cutblocks. Residual areas are cut when the block regeneration has been established and grown to three meters in height. This dispersed model neither retains connectivity in the matrix nor creates large enough new patches to approximate the conditions after most of the fires.

Dispersed patterns of harvesting have been heavily criticized for their effect of contributing to forest fragmentation (Wallen et. al, 1994). Alternate patches of relatively small clearcuts in a dispersed pattern are one of the most efficient models with which to carry out landscape fragmentation (Franklin and Forman, 1987). The production of large amounts of high contrast edge, the decline of interior core areas of patches as well as the creation of altered microclimates has been well studied. The dispersed model has few ecological advantages over the aggregated model of cutting. It is apparent from the regional disturbance analysis that an aggregated model of forest cutting would be a preferable method for approximating the inherent disturbance regime at least in terms of extent.

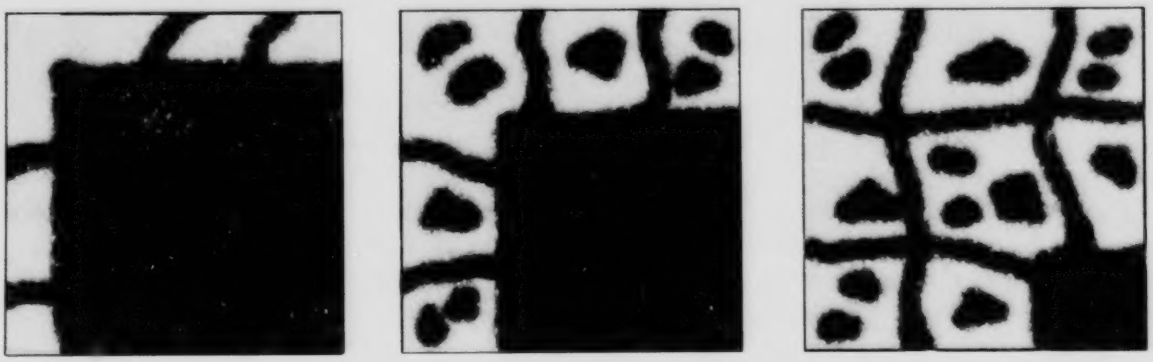
Cutting in the study area has traditionally been carried out in a two pass dispersed model, whereby the first 50% of the area is removed in a dispersed or alternate clearcut. The second pass in which the remaining area is removed takes place after satisfactory regeneration is achieved. Aside from riparian buffers, no real attempt is made to provide for connectivity in the uncut forest. The resultant dispersed cut pattern perforates and fragments the landscape rapidly. In fact, the dispersed pattern is the model to adapt if fragmentation is a management goal. Once the residual blocks are removed, extremely large cutover patches are formed that may or may not have stepping stones or corridors across them. Frequently they do not. The dispersed model of land transformation (many small dispersed cutblocks) is ecologically devastating because of the early loss of large patches (Forman, 1995).

The following patterns should be considered as an alternative to dispersed cutting. Larger blocks than are currently cut should be considered in some landscape management units (particularly the Middle Ridges LMU) if natural or inherent disturbance regimes are to be more closely followed. As they are currently not common and the public may not be aware of their ecological value, large blocks may face public resistance. The problems of large blocks, such as negative visual quality, within block connectivity, potential erosion and water quality issues must be addressed. The following modifications to large blocks should be considered.

4.1.1 "JAWS AND CHUNKS" CUTTING

Forman (1995) has put forward a method of transforming an area by progressively cutting from two sides but at the same time allowing for corridors and stepping stones across the altered landscape. He refers to this as the "jaws and chunks" approach. Very large clearcuts may be possible with this model although some problems such as erosion may still exist. The following diagrams are conceptual and not to scale. They should not be duplicated literally.

FIGURE 80. "JAWS AND CHUNKS" (FORMAN, 1995) WITH REMNANT ISLANDS AND CORRIDORS



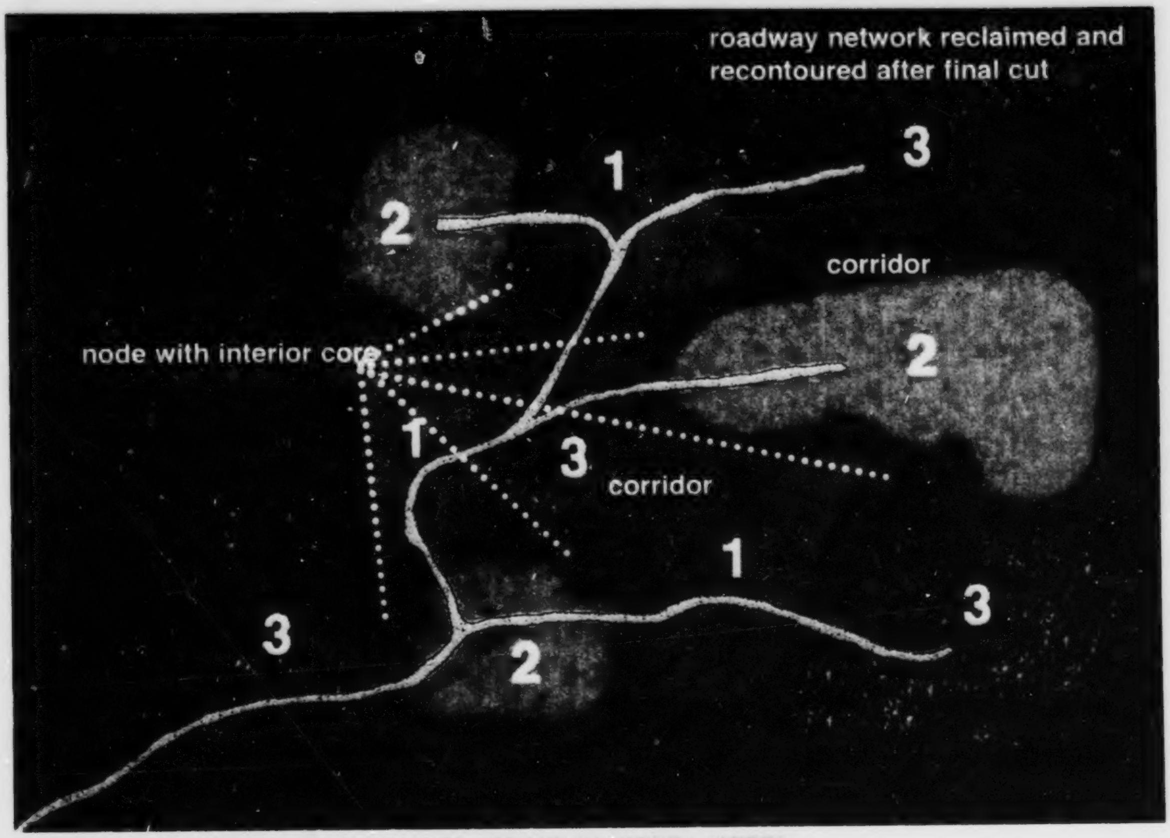


FIGURE 81. CONCEPTUAL DIAGRAM OF "GRAPE CLUSTER" MODEL

1 = area of most recent cut
2 = area cut after vegetation stabilization of area 3
3 = Initial Cut Area

4.1.2 "GRAPE CLUSTER" CUTTING

Large blocks approximating natural fire sizes may be cut in this fashion. The cut area indicated may be as large as 500 ha. It is considered one cutblock area and would likely be cut within 4 to 10 years. The sub–blocks are sequenced, not in consideration of regeneration, but in terms of site stabilization. Once enough vegetation is established on the sub–block to control erosion, the next sequence of sub–blocks is cut. Once the second sequence is stabilized, the third is free to be cut. Corridors are left between the sub–blocks and nodes large enough to provide an interior core are left at intersections in the corridor network. If sub–blocks are larger than 20 ha, some interior stepping stone islands should be provided (with and without interior patch cores). Where possible, sub–block boundaries shall follow vegetation type boundaries. Roads are positioned so as not to pass through nodes. The network of corridors and nodes provides for connectivity as well as providing for a reduction in fetch (wind run) of the blocks. This should reduce evapotranspiration and potentially increase snow accumulation. While portions of the corridor and islands may blow down, this will provide additional large woody debris which has other ecological benefits. In this way, the very large cutblocks required to approximate stand replacement fires may be accommodated while mitigating visual impact, as well as soil erosion and water quality concerns.

REFERENCES

Archibald, J.H., G.D. Klappstein and I.G.W. Corns, 1996, The Field Guide to Ecosites of Southwestern Alberta, Canadian Forest Service, Northwest Region, Northern Forestry Centre, Edmonton, Alberta.

Alberta Dept. of Environmental Protection, 1994, Alberta Vegetation Inventory Standards Manual, Version 2.1, Edmonton, Alberta.

Barret, Stephen W., 1996, The Historic Role of Fire in Waterton Lakes National Park, Alberta, Parks Canada unpublished report.

Bessie, W.C. and E.A. Johnson, 1995, The Relative Importance of Fuels and Weather on Fire Behavior in Subalpine Forests, Ecology: 76(3) pp. 747—762.

Bloomberg, W.J., 1950, Fire and Spruce, Forestry Chronicle, (53) 157—151.

Day, Robert, 1972, Stand Structure, Succession, and Use of Southern Alberta's Rocky Mountain Forest, in Ecology, Vol 53. No. 3.

Dickinson, R.E., 1970, Regional Ecology: The Study of Man's Environment, John Wiley, New York.

Forestry Corp., 1996, Mountain Pine Beetle Hazard Rating System, unpublished internal document prepared for Alberta Environmental Protection, Lands and Forest Service.

Franklin, J.F., and R.T.T. Forman, 1987, Creating landscape patterns by forest cutting: ecological consequences and principles, In Landscape Ecology 1: 5—18.

Hersperger, A. 1998, Personal Communication, Harvard University Graduate School of Design.

Isard, W., 1975, Introduction to Regional Science, Prentice—Hall, Englewood Cliffs, New Jersey, USA.

Johnson, E.A. and C.P.S. Larsen, 1991, Climatically induced change in fire frequency in the southern Canadian Rockies, Ecology, 72:194—201.

Johnson, E.A., K. Miyanishi, H. Kleb, 1994, The hazards of interpretation of static age structures as shown by stand reconstructions in a Pinus contorta — Picea engalmanii forest, in the Journal of Ecology, Vol. 82, 923—931.

Johnson, E.A., K. Miyanishi, J.M.H. Weir, 1995, Old—growth, disturbance, and ecosystem management, Can. Journal Botany Vol. 73: 918—926.

Johnson, E.A., and G.I. Fryer, 1987, Historical vegetation change in the Kananaskis Valley, Canadian Rockies, in Can. Journal Botany Vol. 65.

McGarigal, Kevin and Barbara J. Marks, 1994, FRAGSTATS Spatial Pattern Analysis Program for Quantifying Landscape Structure, Version 2.0 Oregon State University, Corvalis.

McMillan, H.R., 1909, Forest Conditions in the Crowsnest Valley, Alberta, Government Printing Bureau, Ottawa.

Masters, A.M., 1990, Changes in forest fire frequency in Kootenay National Park, Canadian Rockies. Can. J. Bot. 68: 1763—1767.

Miyagawa, Bob, 1994, Mountain Pine Beetle Management, Internal Report of Alberta Environmental Protection, Lands and Forest Service.

Murphy, Peter, 1996, personal communication.

Spies, T.A., and J.F. Franklin, 1988, Old growth and forest dynamics in the Douglas Fir region of western Oregon and Washington, Nat. Areas J. 8:190—201.

Wallin, David O., Frederick J. Swanson, Barbara Marks, 1994, Landscape Pattern Response to Changes in Pattern General Rules: Land Use Legacies in Forestry, in Ecological Applications, 4(3), 1994, pp. 569—580.

APPENDIX 1 Ecosite Phase Classification — General Method

ECOSITE PHASE CLASSIFICATION METHODS

The procedure for identifying ecosite phase has two stages; forest cover classification and subsequently, ecosite phase classification. The general methodology is described as follows.

Forest Cover Classification

The Forest Cover classes were produced by classifying the Alberta Vegetation Inventory (AVI) using a set of conditional statements based upon preliminary work by John Kansas (Kansas, 1996) and extensively modified by Olson+Olson in consultation with Harry Archibald, Harry Stelfox, Mike Willoughby and Mike Alexander. The Alberta Vegetation Inventory Standards Manual, Version 2.1, November, 1994 was referenced.

The AVI was rasterised to a 25 metre resolution and the Polygon Attribute Table (PAT) of the vector source AVI file was imported to the new Raster Attribute Table (RAT). The unique polygon identification numbers were used to merge the data.

Prior to classification, ten new vegetation attributes were derived and added to the RAT. These new attributes were;

- a concatenation of the species abbreviations and percentages from the SP1 to SP5 and SP1_PER to SP5_PER columns yielding the column titled 'Covercat' which contains entries such as: Sw5Pb3Aw2, Aw9Pb1, Se8Fa2, etc.; and
- the summation of percentages of species composition per AVI entry. This was also based on the SPn and SPn_PER columns, producing the columns: Pine%, Balsam%, DougFir%, Larch%, Whitebark/Limber%, Aspen%, Spruce%, TrueFir% and TotalConiferous%.

These derived attributes significantly reduced the complexity of the conditional statements used in the following stages of the classification. AVI attribute conditional statements (refer Appendix) were written to identify cover classes. The conditional statements were executed using the ERDAS Imagine Selection Criteria utility and run on the attribute table of the rasterised AVI. Each conditional statement generates a selection of Raster Attribute Table entries which are then considered to comprise a Forest Cover class.

For simplicity, the coding of the conditional statements has been written in an order dependent manner. This simplicity eliminates the need to verify the exclusivity of the classes at the expense of enforcing a sequential methodology. The sequence in which the conditional statements are applied affects the determination of the class structure in that conditional statements describing classes of a similar nature may 'select' the same cell and it is the order in which the conditional statements are applied that determines the class to which the cell will be assigned. Such dependencies are noted.

Forest Cover with Horizontal Structure

A classification of the AVI incorporating horizontal structure has also been completed. The concept of horizontal structure is discussed in the AVI Standards Manual (Alberta Environmental Protection, 1994).

For the purposes of the horizontal structure classification, two approaches were used. First, several of the original forest cover conditional statements (refer appendix statements numbers 22—30, 34, 35, 42 and 43) were modified. Requirements to differentiate qualified candidates varied by cover class for this set of statements. Second, a new set of conditional statements (numbers 53—73) were prepared to differentiate candidates based upon their 'Understory' attributes in the AVI. The conditional statements were developed with the assistance of Mike Willoughby.

Following the method previously outlined, nine columns quantifying the 'Understory' species attributes USP1 to USP5 and USP1_PER to USP5_PER were prepared and added to the Raster Attribute Table yielding the columns U_Pine%, U_Balsam%, U_TotalConiferous%, etc.

In keeping with the order dependence of the conditional statements, the Horizontal Structure classification required the application of the statements beginning with number 22 and proceeding sequentially through number 73.

Ecosite Phase Classification

Ecosite Phase classification preceded the identification of Ecosites. This was required as some elements of the AVI (notably moisture regime and soil conditions) were of questionable accuracy or lacking. Vegetation was therefore used as partially diagnostic of physiographic conditions. Ecosite phases were identified by the method that follows and subsequently collapsed into Ecosites. Archibald et. al., 1996, was the primary reference document for the ecosite phase classification.

In order to classify Ecosite Phase, the following raster data (all at 25 m resolution) were prepared or acquired:

Alberta Vegetation Inventory
Digital Elevation Model
Aspect
Slope
Slope Position
Forest Cover
Natural Sub Regions
Physical Land Classification @ 1:50 000
Ecological Land Classification @ 1:100 000

Models were developed for each ecosite phase and were based upon conditional criteria calls for the various map inputs. Models were run for individual ecosite phases. The results were then draped over the digital terrain model, verified against the AVI and other input maps, evaluated by departmental experts and the criteria statement modified as necessary. Harry Archibald, Harry Stelfox, Mike Willoughby, Mike Alexander and Barry Adams assisted in the construction of the models. The models were produced and executed using the ERDAS Imagine 8.3 Spatial Modelling tool (refer to appendix for individual model descriptions). Each model was numbered in a manner consistent with the indexing system utilized in the reference document, Field Guide to Ecosites of Southwestern Alberta (Archibald et. al., 1994).

Models were designed for three natural sub regions, Subalpine (9 classes), Montane (12 classes) and Grasslands (17 classes). As boundaries between the sub regions were not always abrupt, additional classes, namely Transitional Subalpine (10 classes) and Transitional Montane (2 classes) regions were subsequently identified and models developed for them separately. Transitional Subalpine were areas in the subalpine where douglas fir or aspen were found and the Montane rules were applied whereas Transitional Montane were areas in the montane where predominantly subalpine species were found and therefore, the rules for the Subalpine were applied. The Montane models were applied to both the Foothills Parkland (12 classes) and Foothills Fescue (12 classes) regions.

An iterative process of running and summing the individual models for the various Natural Sub Regions (NSR) then examining the results for overwrites and omissions (refer note on Overwrites and Missing Forest Cover types in Appendix) of Forest Cover types guided the development of individual model criteria towards exclusivity. "Overwrite" as used here indicates the situation where cells have been classified by more than one Ecosite Phase model. It is possible to 'protect' classes from being overwritten during the intermediate summation process. Although useful in practice, this weakens the classification protocols as absolute exclusivity for the classes involved has not been achieved. The iterative procedure and continued refinement in the models' discriminations was practiced to reduce to an acceptable minimum the instances where such 'protection' would be necessary.

Once an aggregate map of ecosites had been created, a filtering procedure was run on the data to eliminate patches less than 4 pixels or less than .25 ha. Herbaceous clearcuts were assigned to the most frequently occurring ecosite surrounding it and subsequently given the phase identifier of Hc.

In order to adequately describe some 'complex' AVI polygons, a further refinement of the grasslands ecosite phase classification is currently underway treating the concepts of "Multi—layered canopy (two—story)" and "Horizontal" structure together. Those AVI polygons which are described as having Multi—layered or Horizontal structure are identified and selected for treatment if their overstory contains tree species and their understory (specifically the UNFL column) contains one of these components:

Herbaceous Grassland (HG)
Herbaceous Forbs (HF)
Shrub Closed (SC)
Shrub Open (SO)

All the resulting 'ecosite phase complexes' have been identified by a concatenation of their over and understory classes. Subsequent calculation of forage potential on these sites will take in to account either the USTRUC_VALU percentage, in the case of elements with Horizontal Structure, or the DENSITY call of the overstory, in the case of elements with Multi—layered Structure. Timber volume calculations will continue to use the overstory attributes, but will account for the percentage of the stand which is occupied by trees.

APPENDIX 2 Forest Cover Classification Conditional Statements

The Forest Cover classes were produced by re—classifying the Alberta Vegetational Inventory (AVI) of the Southern Rockies Landscape Planning Pilot Study (SRLPP) area. This re—classification was conducted using a set of conditional statements based upon preliminary work by John Kansas and extensively modified by Olson+Olson in consultation with Harry Archibald, Harry Stelfox, Mike Willoughby and Mike Alexander and utilizing the Alberta Vegetational Inventory Standards Manual, Version 2.1, November, 1994.

The AVI was rasterised to a 25 metre resolution and the Polygon Attribute Table of the source AVI file was imported to the Raster Attribute Table of the object AVI file.

Prior to re—classification, ten new attributes were derived and added to the Raster Attribute Table. These additions represent (1) a concatenation of the species abbreviations and percentages from the SPn and SPn_PER columns yielding the column titled 'Covercat' which contains entries such as: Sw5Pb3Aw2, Aw9Pb1, Se8Fa2, etc. and (2) the summation of percentages of species composition per AVI entry also based on the SPn and SPn_PER columns, producing the columns: Pine%, Balsam%, DougFir%, Larch%, Whitebark/Limber%, Aspen%, Spruce%, TrueFir% and TotalConiferous%. These derived attributes significantly reduce the computational demands placed upon the conditional statements.

For simplicity of coding, the conditional statements have been written so that they are order dependent. This simplicity relieves the code of having to verify the exclusivity of the classes they describe at the expense of enforcing a sequential methodology. The sequence in which the conditional statements are applied affects the determination of the class structure in that conditional statements describing classes of a similar nature may 'select' the same cell and it is the order in which the conditional statements are applied that determines the class to which the cell will be assigned. Such dependencies have been noted in the file Forest Cover Conditionals, which is appended below.

The conditional statements were executed using the ERDAS Imagine Selection Criteria utility and run on the Raster Attribute Table of the rasterised AVI. Each conditional statement generates a selection of Raster Attribute Table entries which are then considered to comprise a Forest Cover class.

The current version of the Forest Cover Conditionals contains 52 classes, which are delineated by consecutively numbered conditional statements; 33 of these classes have been defined for use in the SRLPP and 19 have been defined following the AVI Standards Manual.

Example of conditional statement describing the 'Pine' class

1. Pine

```
($"Pine%" >= 9 and $"Larch%" == 0) or
($"Pine%" >= 5 and ($"Balsam%" + $"Aspen%" < 2) and
$"Pine%" > $"Spruce%" and $"Pine%" > $"TrueFir%" and $"Pine%" > $"DougFir%" and
$"Larch%" == 0)
```

where the single digits refer to percentages in powers of ten (i.e., 9 = 90%, etc.).

At the direction of Harry Archibald, a re–classification of the AVI incorporating consideration of Horizontal Structure has also been completed.

The concept of Horizontal Structure is discussed in the AVI Standards Manual, cf. 2.2.2.6.

For the purposes of this re–classification, two approaches are required: first, several of the original conditional statements viz. 22–30, 34, 35, 42 and 43 were modified to recognize and differentiate their treatment of qualified candidates. Second, a new set of conditional statements (numbers 53–73) were prepared, syntactically similar to statements 1–21, but functionally different in that they treat candidates based specifically upon their 'Understory' attributes in the AVI.

Following the method outlined above, nine columns quantifying the 'Understory' attributes, USPn and USPn_PER were prepared and added to the Raster Attribute Table yielding similar columns, namely, U_Pine%, U_Balsam%, U_TotalConiferous%, etc.

In keeping with the order dependence of the conditional statements, the Horizontal Structure re–classification required the application of the conditionals statements beginning with number 22 and proceeding sequentially through number 73.

As noted, conditional statements 22–30, 34, 35, 42 and 43 were modified to recognize and functionally differentiate their treatment of qualified candidates. These classes are:

22	Shrub Wetland
23	Shrub Meadow Open Mesic
24	Shrub Meadow Open Dry
25	Shrub Meadow Closed Mesic
26	Shrub Meadow Closed Dry
27	Rough Pasture Open Mesic
28	Rough Pasture Open Dry
29	Rough Pasture Closed Mesic
30	Rough Pasture Closed Dry
34	Grassland Mesic
35	Grassland Dry
42	Rock Barren
43	Cutbank/Sand

which were adapted individually with respect to the particularities of their Horizontal Structure. These conditional statements were developed with the assistance of Mike Willoughby. It is within these classes that the main effects of implementing Horizontal Structure can be noted. In practice, this means that AVI entries with forested components which qualify according to one of these conditional statements (and which have already been classified according to conditional statements 1–21) will now be reassigned to one of these classes. Also, in the case of numbers 42 and 43, entries already classified according to statements 1–21, 22–30, 34, or 35 might now be reassigned.

The following examples illustrate implementation of Horizontal Structure calls in the above group of conditional statements.

42. Rock Barren

```
$"NAT_NON" contains "NMR" or ($"STRUC" == "H" and $"UNAT_NON" contains "NMR" and
$"USTRUC_VAL" >= 6)
```

43. Cutbank/Sand

```
$"NAT_NON" contains "NMC" or $"NAT_NON" contains "NMS" or ($"STRUC" == "H" and
$"USTRUC_VAL" >= 6 and ($"UNAT_NON" contains "NMC" or $"UNAT_NON" contains "NMS"))
```

The following conditional statement was employed to determine candidacy of 'forested' cover classes (already classified by conditional statements 1—21) for conditional statements 53—73:

```
$"STRUC" == "H" and $"USTRUC_VAL" > 5 and $"USPI" != "" and (U_Forestcover conditional)
```

where STRUC, USTRUC_VAL and USPI are column headings from the AVI and (U_Forestcover conditional) relates to the set of Forest Cover Conditionals, 53—73.

As an example, the following is the conditional statement prepared for Horizontal Structure re—classification describing the 'Pine' class.

53. Pine

```
$"STRUC" == "H" and $"USTRUC_VAL" > 5 and $"USPI" != "" and
($"U_Pine%" >= 9 and $"U_Larch%" == 0) or
($"U_Pine%" >= 5 and ($"U_Balsam%" + $"U_Aspen%" < 2) and
$"U_Pine%" > $"U_Spruce%" and $"U_Pine%" > $"U_TrueFir%" and $"U_Pine%" >
$"U_DougFir%" and $"U_Larch%" == 0)
```

The following are the Forest Cover Classes:

Pine
Spruce
Subalpine Fir
Douglas Fir
Subalpine Larch
Whitebark/Limber Pine
Aspen
Balsam Poplar
Aspen Mixedwood
Balsam Poplar Mixedwood
Pine Mixedwood
Spruce Mixedwood
Subalpine Fir Mixedwood
Douglas Fir Mixedwood
Mixed Conifer (Pine)
Mixed Conifer (Spruce)
Mixed Conifer (True Fir)
Mixed Conifer (Douglas Fir)
Mixed Conifer (Whitebark/Limber Pine)
Mixed Conifer (Larch)
Spruce Wetland
Shrub Wetland
Shrub Meadow Open Mesic
Shrub Meadow Open Dry
Shrub Meadow Closed Mesic
Shrub Meadow Closed Dry
Rough Pasture Open Mesic
Rough Pasture Open Dry
Rough Pasture Closed Mesic
Rough Pasture Closed Dry
Wet Graminoid
Annual Crops
Perennial Forage Crops
Grassland Mesic
Grassland Dry
Gravel Pits/Surface Mines
Rural Residential
Hamlets, Villages and Towns
Non—veg ROWs
Farmsteads
Plant Sites/Sewage Lagoons
Rock Barren
Cutbank/Sand
River
Lakes/Ponds
Permanent Ice/Snow
Industrial Reclamation—Vegetated
Forb Meadow
Flooded
Bryophytic Pond
Forested Clearcuts
Herbaceous Clearcuts

Forest Cover Conditional Statements:

1. Pine

```
(Pine% >= 9 and Larch% == 0)
or
(Pine% >= 5
and (Balsam% + Aspen% < 2)
and Pine% > Spruce%
and Pine% > TrueFir%
and Pine% > DougFir%
and Larch% == 0)
```

2. Spruce

```
Spruce% >= 9
or
(Spruce% >= 5
and (Balsam% + Aspen% < 2)
and Spruce% >= Pine%
and Spruce% > TrueFir%
and Spruce% > DougFir%
and Larch% == 0)
and not
(Spruce% == 5 and TrueFir% == 5)
```

NB. Whitebark/Limber Pine must be run AFTER Spruce to reclaim its rows.

NB. Mixed Conifer (Larch) must be run AFTER Spruce to reclaim its rows.

3. Subalpine Fir

```
(TrueFir% >= 9 and Larch% == 0)
or
(TrueFir% == 5 and Spruce% == 5)
or
(TrueFir% >= 5
 and (Balsam% + Aspen% < 2)
and TrueFir% >= Pine%
and TrueFir% >= Spruce%
and TrueFir% > DougFir%
and Larch% == 0)
```

4. Douglas Fir

```
(DougFir% >= 9 and Larch% == 0)
or
(DougFir% == 5 and Pine% == 5)
or
(DougFir% == 5 and Spruce% == 5)
or
(DougFir% >= 5
and (Balsam% + Aspen% < 2)
and DougFir% >= Pine%
and DougFir% >= Spruce%
and DougFir% > TrueFir%
and Larch% == 0)
```

5. Subalpine Larch

```
Larch% >= 9
or
(Larch% >= 5
and (Balsam% + Aspen% < 2)
and Larch% >= Pine%
and Larch% >= Spruce%
and Larch% >= TrueFir%
and Larch% >= DougFir%)
```

6. Whitebark/Limber Pine

```
((SP1 == Pa OR SP1 == Pf)  and SP1_PER >= 5 )
or
((SP2 == Pa OR SP2 == Pf)  and SP2_PER >= 5 )
and
(Aspen% + Balsam% < 2) and Larch% == 0
```

7. Aspen

```
Aspen% >= 4
and TotalConiferous <= 4
and Aspen% > Balsam%
```

NB. The Aspen Mixedwood criteria must be run AFTER the Aspen criteria to reclaim its rows.

8. Balsam Poplar

```
Balsam% >=5 and TotalConiferous < 2
```

9. Aspen Mixedwood

```
Aspen% >= 4
and TotalConiferous >= 2
and TotalConiferous <= 4
and Aspen% > Balsam%
and Larch% == 0
```

NB. The Aspen Mixedwood criteria must be run AFTER the Aspen criteria to reclaim its rows.

10. Balsam Poplar Mixedwood

```
(Balsam% > 5
and TotalConiferous >= 2
and TotalConiferous <= 4
and Aspen% <= Balsam%)
or
(Balsam% <= 8
and (Balsam% + Aspen% > TotalConiferous)
and Aspen% <= Balsam%
and TotalConiferous > 1)
```

11. Pine Mixedwood

(Balsam% + Aspen% <= TotalConiferous)
and (Balsam% + Aspen% >= 2)
and Pine% > Spruce%
and Pine% > TrueFir%
and Pine% > DougFir%
and TotalConiferous >= 3

12. Spruce Mixedwood

(Balsam% + Aspen% <= TotalConiferous)
and Spruce% >= Pine%
and Spruce% > TrueFir%
and Spruce% > DougFir%
and TotalConiferous >= 3
and (Balsam% + Aspen% >= 2)

NB. Spruce Wetland must be run
AFTER Spruce Mixedwood to reclaim its rows.

13. Subalpine Fir Mixedwood

(Balsam% + Aspen% <= TotalConiferous)
and TrueFir% >= Pine%
and TrueFir% > DougFir%
and TrueFir% >= Spruce%
and TrueFir% > Larch%
and TotalConiferous >= 3
and (Balsam% + Aspen% >= 2)

14. Douglas Fir Mixedwood

(Balsam% + Aspen% <= TotalConiferous)
and DougFir% >= Pine%
and DougFir% > TrueFir%
and DougFir% >= Spruce%
and TotalConiferous >= 3
and (Balsam% + Aspen% >= 2)

NB. Mixed Conifer (Douglas Fir) must be run
AFTER Douglas Fir Mixedwood to reclaim its rows.

15. Mixed Conifer (Pine)

Balsam% + Aspen% <= 1
and Pine% > DougFir%
and Pine% > TrueFir%
and Pine% > Spruce%
and Pine% <= 4
and Larch% == 0

16. Mixed Conifer (Spruce)

Balsam% + Aspen% <= 1
and Spruce% > DougFir%
and Spruce% > TrueFir%
and Spruce% >= Pine%
and Spruce% <= 4
and Larch% == 0

17. Mixed Conifer (True Fir)

Balsam% + Aspen% == 0
and TrueFir% > DougFir%
and TrueFir% >= Spruce%
and TrueFir% >= Pine%
and TrueFir% <= 4
and Larch% == 0

NB. Mixed Conifer (Whitebark/Limber Pine)
must be run AFTER Mixed Conifer (True Fir)
to reclaim its rows.

18. Mixed Conifer (Douglas Fir)

Balsam% + Aspen% == 0
and DougFir% >= TrueFir%
and DougFir% >= Spruce%
and DougFir% >= Pine%
and Larch% == 0
and DougFir% <= 4
and DougFir% != 0

19. Mixed Conifer (Whitebark/Limber Pine)

CoverCAT CONTAINS Pa
or
CoverCAT CONTAINS Pf
and
(Forestcover != Whitebark/Limber Pine
and Whitebark/limber% <= 4
and Whitebark/limber% >= Larch%
and Whitebark/limber% >= DougFir%
and Whitebark/limber% >= TrueFir%
and Whitebark/limber% >= Pine%
and Whitebark/limber% >= Spruce%
and Larch% == 0)

NB. Mixed Conifer (Whitebark/Limber Pine)
must be run AFTER Whitebark/Limber Pine
to function properly.

NB. Mixed Conifer (Whitebark/Limber Pine)
must be run AFTER Mixed Conifer (True Fir)
to function properly.

20. Mixed Conifer (Larch)

Larch% < 5 and Larch% > 0

21. Spruce Wetland

Forestcover CONTAINS Spruce and
(MOIST_REG == a OR MOIST_REG == w)

NB. Spruce Wetland must be run AFTER Spruce to reclaim its rows.

NB. Spruce Wetland must be run AFTER Spruce Mixedwood to reclaim its rows.

22. Shrub Wetland

(NFL == SC OR NFL == SO and
(MOIST_REG == a OR MOIST_REG == w))
or
(STRUC == H and USTRUC_VAL > 2 AND
(UNAT_NON == NWL or UNAT_NON == NWF))

23. Shrub Meadow Open Mesic

MOIST_REG == m
and (NFL == SO
or
(STRUC == H and UNFL == SO
and USTRUC_VAL > 5))

24. Shrub Meadow Open Dry

MOIST_REG == d
and (NFL == SO or (STRUC == H and
UNFL == SO and USTRUC_VAL > 5))

25. Shrub Meadow Closed Mesic

MOIST_REG == m
and
(NFL == SC or (STRUC == H and
((UNFL == HG and USTRUC_VAL < 5)
or (UNFL == SC and USTRUC_VAL > 5))))

26. Shrub Meadow Closed Dry

MOIST_REG == d
and
(NFL == SC or (STRUC == H and
((UNFL == HG and USTRUC_VAL < 5)
or (UNFL == SC and USTRUC_VAL > 5
and UNAT_NON CONTAINS NWR))))

27. Rough Pasture Open Mesic

MOIST_REG == m
and ANTH_VEG == CPR
and (NFL == SO or (STRUC == H
and UNFL == SO and USTRUC_VAL > 5))

28. Rough Pasture Open Dry

MOIST_REG == d
and ANTH_VEG == CPR
and (NFL == SO or (STRUC == H
and UNFL == SO and USTRUC_VAL > 5))

29. Rough Pasture Closed Mesic

MOIST_REG == m
and ANTH_VEG == CPR
and (NFL == SC or (STRUC == H
and UNFL == SC and USTRUC_VAL > 5))

30. Rough Pasture Closed Dry

MOIST_REG == d
and ANTH_VEG == CPR
and (NFL == SC
or (STRUC == H and UNFL == SC and USTRUC_VAL > 5))

31. Wet Graminoid

NFL == HG and (MOIST_REG == a or MOIST_REG == w)

32. Annual Crops

ANTH_VEG == CA

33. Perennial Forage Crops

ANTH_VEG == CP

34. Grassland Mesic

MOIST_REG == m
and
(NFL == HG or (STRUC == H
and UNFL == HG and USTRUC_VAL > 4)))
or
(STRUC == H and UNFL == HG
and USTRUC_VAL <= 5
and (UNAT_NON == NMC or
UNAT_NON == NMR or UNAT_NON == NMS)

35. Grassland Dry

MOIST_REG == d
and
((NFL == HG) or (STRUC == H
and UNFL == HG and USTRUC_VAL > 4)))
or
(STRUC == H and UNFL == HG
and USTRUC_VAL <= 4
and (UNAT_NON == NMC
or UNAT_NON == NMR or UNAT_NON == NMS)

36. Gravel Pits/Surface Mines

ANTH_NON CONTAINS AIG
or ANTH_NON CONTAINS AIM

37. Rural Residential

ANTH_NON CONTAINS ASR

38. Hamlets, Villages and Towns

ANTH_NON CONTAINS ASC

39. Non–veg ROWs

ANTH_NON CONTAINS AIH

40. Farmsteads

ANTH_NON CONTAINS AIF

41. Plant Sites/Sewage Lagoons

ANTH_NON CONTAINS AII

42. Rock Barren

NAT_NON CONTAINS NMR
or
(STRUC == H and UNAT_NON
CONTAINS NMR and USTRUC_VAL >= 6)

43. Cutbank/Sand

(NAT_NON CONTAINS NMC
or NAT_NON CONTAINS NMS)
or
(STRUC == H and USTRUC_VAL >= 6
and (UNAT_NON CONTAINS NMC
or UNAT_NON CONTAINS NMS))

44. River

NAT_NON CONTAINS NWR

45. Lakes/Ponds

NAT_NON CONTAINS NWL

46. Permanent Ice/Snow

NAT_NON CONTAINS NWI

47. Industrial Reclamation—Vegetated

ANTH_VEG CONTAINS CIP
or ANTH_VEG CONTAINS CIW

48. Forb Meadow

NFL CONTAINS HF

49. Flooded

NAT_NON == NWF

50. Bryophytic Pond

NFL == BR

51. Forested Clearcut

MOD1_EXT <= 4
and MOD1 == CC and SP1 != “”

52. Herbaceous Clearcut

MOD1_EXT <= 5 and MOD1 == CC and NFL != “”

Forest Cover Conditionals Relating to Horizontal Structure:

```
STRUC == H and USTRUC_VAL >= 5 and USPI !=
and (U_Forestcover conditional)
```

53. Pine

```
(U_Pine% >= 9 and U_Larch% == 0)
or
(U_Pine% >= 5
and (U_Balsam% + U_Aspen% < 2)
and U_Pine% >  U_Spruce%
and U_Pine% > U_TrueFir%
and U_Pine% > U_DougFir%
and U_Larch% == 0)
```

54. Spruce

```
U_Spruce% >= 9
or
(U_Spruce% >= 5
and (U_Balsam% + U_Aspen% < 2)
and U_Spruce% >= U_Pine%
and U_Spruce% > U_TrueFir%
and U_Spruce% > U_DougFir%
and U_Larch% == 0)
and not
(U_Spruce% == 5 and U_TrueFir% == 5)
```

NB. Whitebark/Limber Pine must be run AFTER Spruce to reclaim its rows.

NB. Mixed Conifer (Larch) must be run AFTER Spruce to reclaim its rows.

55. Subalpine Fir

```
(U_TrueFir% >= 9 and U_Larch%== 0)
or
(U_TrueFir% == 5 and U_Spruce% == 5)
or
(U_TrueFir% >= 5
and (U_Balsam% + U_Aspen% < 2)
and U_TrueFir% >= U_Pine%
and U_TrueFir% >= U_Spruce%
and U_TrueFir% > U_DougFir%
and U_Larch% == 0)
```

56. Douglas Fir

```
(U_DougFir% >= 9 and U_Larch% == 0)
or
(U_DougFir% == 5 and U_Pine% == 5)
or
(U_DougFir% == 5 and U_Spruce% == 5)
or
(U_DougFir% >= 5
and (U_Balsam% + U_Aspen% < 2)
and U_DougFir% >= U_Pine%
and U_DougFir% >= U_Spruce%
and U_DougFir% > U_TrueFir%
and U_Larch% == 0)
```

57. Subalpine Larch

```
U_Larch% >= 9
or
(U_Larch% >= 5
and (U_Balsam% + U_Aspen% < 2)
and U_Larch% >= U_Pine%
and U_Larch% >= U_Spruce%
and U_Larch% >= U_TrueFir%
and U_Larch% >= U_DougFir%)
```

58. Whitebark/Limber Pine

```
((USPI == Pa or USPI == Pf)
and USPI_PER >= 5 )
or
((USP2 == Pa or USP2 == Pf)
and USP2_PER >= 5 )
and
(U_Aspen% + U_Balsam% < 2)
and U_Larch% == 0
```

59. Aspen

```
U_Aspen% >= 4
and U_TotalConiferous <=4
and U_Aspen% > U_Balsam%
```

NB. The Aspen Mixedwood criteria must be run AFTER the Aspen criteria to reclaim its rows.

60. Balsam Poplar

```
U_Balsam% >= 5
and U_TotalConiferous < 2
```

61. Aspen Mixedwood

```
U_Aspen% >= 4
and U_TotalConiferous >= 2
and U_TotalConiferous <= 4
and U_Aspen% > U_Balsam%
and U_Larch% == 0
```

NB. The Aspen Mixedwood criteria must be run AFTER the Aspen criteria to reclaim its rows.

62. Balsam Poplar Mixedwood

```
(U_Balsam% > 5 and U_TotalConiferous >= 2
and U_TotalConiferous <= 4
and U_Aspen% <= U_Balsam%)
or
(U_Balsam% <= 8
and (U_Balsam% + U_Aspen% > U_TotalConiferous)
and U_Aspen% <= U_Balsam%
and U_TotalConiferous > 1)
```

63. Pine Mixedwood

```
(U_Balsam% + U_Aspen% <= U_TotalConiferous)
and (U_Balsam% + U_Aspen% >= 2)
and U_Pine% > U_Spruce%
and U_Pine% > U_TrueFir%
and U_Pine% > U_DougFir%
and U_TotalConiferous >= 3
```

64. Spruce Mixedwood

```
(U_Balsam% + U_Aspen% <= U_TotalConiferous)
and U_Spruce% >= U_Pine%
and U_Spruce% > U_TrueFir%
and U_Spruce% > U_DougFir%
and U_TotalConiferous >= 3
and (U_Balsam% + U_Aspen% >= 2)
```

NB. Spruce Wetland must be run AFTER Spruce Mixedwood to reclaim its rows.

65. Subalpine Fir Mixedwood

```
(U_Balsam% + U_Aspen% <= U_TotalConiferous)
and U_TrueFir% >= U_Pine%
and U_TrueFir% > U_DougFir%
and U_TrueFir% >= U_Spruce%
and U_TrueFir% > U_Larch%
and U_TotalConiferous >= 3
and (U_Balsam% + U_Aspen% >= 2)
```

66. Douglas Fir Mixedwood

```
(U_Balsam% + U_Aspen% <= U_TotalConiferous)
and U_DougFir% >= U_Pine%
and U_DougFir% > U_TrueFir%
and U_DougFir% >= U_Spruce%
and U_TotalConiferous >= 3
and (U_Balsam% + U_Aspen% >= 2)
```

NB. Mixed Conifer (Douglas Fir) must be run AFTER Douglas Fir Mixedwood to reclaim its rows.

67. Mixed Conifer (Pine)

```
U_Balsam% + U_Aspen% <= 1
and U_Pine% > U_DougFir%
and U_Pine% > U_TrueFir%
and U_Pine% > U_Spruce%
and U_Pine% <= 4
and U_Larch% == 0
```

68. Mixed Conifer (Spruce)

```
U_Balsam% + U_Aspen% <= 1
and U_Spruce% > U_DougFir%
and U_Spruce% > U_TrueFir%
and U_Spruce% >= U_Pine%
and U_Spruce% <= 4
and U_Larch% == 0
```

69. Mixed Conifer (True Fir)

```
U_Balsam% + U_Aspen% == 0
and U_TrueFir% > U_DougFir%
and U_TrueFir% >= U_Spruce%
and U_TrueFir% >= U_Pine%
and U_TrueFir% <= 4
and U_Larch% == 0
```

NB. Mixed Conifer (Whitebark/Limber Pine) must be run AFTER Mixed Conifer (True Fir) to reclaim its rows.

70. Mixed Conifer (Douglas Fir)

```
U_Balsam% + U_Aspen% == 0
and U_DougFir% >= U_TrueFir%
and U_DougFir% >= U_Spruce%
and U_DougFir% >= U_Pine%
and U_DougFir% <= 4
and U_DougFir% != 0
and U_Larch% == 0
```

71. Mixed Conifer (Whitebark/Limber Pine)

```
(USPI == Pa OR USPI == Pf)
or
(USP2 == Pa OR USP2 == Pf)
or
(USP3 == Pa OR USP3 == Pf)
or
(USP4 == Pa OR USP4 == Pf)
or
(USP5 == Pa OR USP5 == Pf)
and Forestcover != U_Whitebark/Limber Pine
and U_Whitebark/limber% <= 4
and (U_Whitebark/limber% >= U_Larch%
and  U_Whitebark/limber% >= U_DougFir%
and U_Whitebark/limber% >= U_TrueFir%
and U_Whitebark/limber% >= U_Pine%
and U_Whitebark/limber% >= U_Spruce%)
and U_Larch% == 0
```

NB. Mixed Conifer (Whitebark/Limber Pine) must be run AFTER Whitebark/Limber Pine to function properly.

NB. Mixed Conifer (Whitebark/Limber Pine) must be run AFTER Mixed Conifer (True Fir) to function properly.

72. Mixed Conifer (Larch)

```
U_Larch% < 5 and U_Larch% > 0
```

73. Spruce Wetland

```
Forestcover CONTAINS Spruce and
(UMOIST_REG == a or UMOIST_REG == w)
```

NB. Spruce Wetland must be run AFTER Spruce to reclaim its rows.

NB. Spruce Wetland must be run AFTER Spruce Mixedwood to reclaim its rows.

Relational Operators

<	IS LESS THAN
<=	IS LESS THAN OR EQUAL TO
>	IS GREATER THAN
>=	IS GREATER THAN OR EQUAL TO
!=	IS NOT EQUAL TO

CONTAINS :
IS PRESENT EXACTLY
AS IT EXISTS AS A TEXT STRING

e.g., "Forestcover CONTAINS Spruce" WOULD BE TRUE FOR 'Spruce' or 'Spruce Mixedwood' or 'Mixed Conifer (Spruce)' BUT WOULD BE FALSE FOR 'SPRUCE'

APPENDIX 3 Ecosite Phase Classification Detailed Methods and Conditional Statements

OUTLINE OF THE DERIVATION OF THE ECOSITE PHASE MAP

Prepared(*) / Acquired(#) Base Maps (raster inputs):
Aspect*
Alberta Vegetational Inventory#
Elevation#
Forest Cover*
Natural Sub Regions*
Physical Land Classification#
Slope*
Slope Position*

Reference Document:
Field Guide to Ecosites of Southwestern Alberta, Archibald, Klappstein, Corns
Canadian Forest Service, Northwest Region, Northern Forestry Centre, 1996.

Ecosite Phase Criteria File: /usr/shawn/Conditionals/Current_EcositePhase_Conditionals

Models: /mnt/c5/models/REVISED_ELC_ELCG_models/

The models were produced and run using the ERDAS Imagine Spatial Modeler.

A model [1] was developed for each Ecosite Phase identified by Harry Archibald, Harry Stelfox, Mike Willoughby, Mike Alexander and Barry Adams. Each model was numbered in a manner consistent with the indexing system utilized in the reference document, Field Guide to Ecosites of Southwestern Alberta, as illustrated in the following Ecosite Phase Class Name:

LICHEN LODGEPOLE PINE (811)

Where the first digit (or second digit in the case of 4 digit numbers) refers to the Natural Sub Region (NSR) map code number (with exceptions noted in the Natural Sub Region List, below) of the C5 study area, in this instance "8" refers to the Subalpine NSR. Regardless of the noted exceptions, the Ecosite Phase Number accurately indexes the Field Guide.

For coding purposes, the project has restricted the alphanumeric index system used in the Field Guide to a purely numeric index. Therefore, the second digit represents its alphabetic transliteration i.e., 1 = a, 2 = b, 3 = c, etc., in this instance then we are looking at the 8 = Subalpine, 1 = "a" Ecosite — lichen (xeric/poor) cf. page 10—3 of the guide.

The third digit identifies the Ecosite Phase, so in this instance we are looking at the 8 = Subalpine, 1 = "a" 1 (8a1) Ecosite Phase — lichen Pl cf. page 10—10 of the guide.

The outputs of each model are numbered in this manner.

Models were designed for three main regions, Subalpine (9 classes), Montane (12 classes) and Grasslands (17 classes). The Transitional Subalpine (10 classes) and Transitional Montane (2 classes) regions were subsequently identified and models developed for them separately. The Montane models were applied to both the Foothills Parkland (12 classes) and Foothills Fescue (12 classes) regions.

An iterative process of running and summing the individual models for the various NSR then examining the results for overwrites (see Note on Overwrites below) and omissions (see Note on Missing Forest Cover types below) of Forest Cover types guided the development of individual model criteria towards exclusivity. "Overwrite" as used here indicates the situation where cells have been classified by more than one Ecosite Phase model. It is possible to 'protect' classes from being overwritten during the intermediate summation process, although useful in practice (see note *1 below) this obviously weakens the case for the classification protocols in as much as it admits that exclusivity for the classes involved has not been achieved. The iterative procedure and continued refinement in the models' discriminations was practiced to reduce to an acceptable minimum the instances where such 'protection' would be necessary.

NSR summations produced the following subtotals:

3900_addition.img	Foothills Parkland
4900_addition.img	Foothills Fescue
FG_addition.img	Grasslands
8_PLUS_trans_conditional.img	Subalpine and Transitional Subalpine
9_PLUS_trans_conditional.img	Montane and Transitional Montane
Herb_CC_only_classified.img	Herbaceous Clearcuts

The first three processes consist of simply summing the individual model outputs for the associated NSR. The fourth and fifth processes also sum the individual model outputs for the associated NSR, but utilize conditional statements to protect some classes from overwriting (see note *1 below); while the last process 'Herbaceous Clearcuts' is dealt with below.

Once the classification of the NSRs was completed, the output of their subtotals were aggregated into a 'TOTAL Ecosite Phase' summation — this file becomes the Proposed_EcositePhase.img (use of the prefix 'Proposed_' is simply to protect 'Current_' files as well as indicating their state of development) but it remains to be processed through the Herbaceous Clearcuts considerations.

An Herbaceous_Clearcuts.img file was derived from the Forestcover.img file and was INDEXED (*2) to the Proposed_EcositePhase.img. This index operation produced the EcositePhase_HerbCC_Index.img' file with the Proposed_EcositePhase.img attributes intact as well as an added entry for Herbaceous Clearcuts.

Ecosite Phase classification of stands identified as Herbaceous Clearcuts was obtained (by inference) using a Zonal Majority Scan [4] (*3) in which the most predominant existing Ecosite Phase in the vicinity of each cell comprising an Herbaceous Clearcut was accorded that value. This yields the EcositePhase_HerbCC_classified.img.

The Herbaceous_Clearcuts.img was then INDEXED to the EcositePhase_HerbCC_classified.img to yield the EcositePhase_HerbCC_classified_INDEX.img. This operation was performed to identify the contributors to the Herbaceous Clearcuts Ecosite Phase classification.

The EcositePhase_HerbCC_classified_INDEX.img was then RECODED to meet the following criteria:

1) ANY Herbaceous Clearcuts Ecosite Phase LESS THAN 2 hectares was ignored.
2) ANY Herbaceous Clearcuts Ecosite Phase LESS THAN 10 hectares was rolled up into its precursor.
3) ALL Grassland HerbCC Ecosite Phases were rolled up into their precursors.

The result: Current_EcositePhase.img.

The file Current_EcositePhase.img can then be used as the input to the model [5] which produces the Proposed_Ecosites.img (see OUTLINE OF THE DERIVATION OF THE ECOSITES MAP below).

Note on Overwrites:
Because each model's output is identified by its Ecosite Phase Number (which is to say that the histogram of each model .img file contains a none zero value only in the row corresponding to the Ecosite Phase Number — e.g. model 911's histogram will have one none zero entry at row 911) when the models for an NSR are summed, any cells which have been classified by more than one model will produce a histogram value equal to the sum of the models' Ecosite Phase Numbers viz. a cell classified by both models 911 and 912 will produce a histogram entry in the NSR summation .img file at row 1823. The overwrite entries can then be examined, contributors identified and criteria revised.

Note on Missing Forest Cover types:

More difficult than identifying cells which have been classified twice is identifying cells which have not been classified at all. To assist in this aspect of the classification process, a set of models [2] have been prepared to produce .img files of unclassified Forest Cover types for each NSR. These files are constructed using a series of MATRIX operations. The resulting histogram is exported as a text file and processed with the Unix text editing/pattern scanning program (nawk) [3] producing a table identifying any missing Forest Cover types and these associated attributes:

Aspect
Density
Moisture
Regime
Slope

in the form:

Pine	North	A	m	1	8	14	1	0
Pine	South	A	m	3	38	18	48	0
Subalpine Fir	South	A	m	0	2	0	0	0

where the 5 columns of numbers represent the unclassified cells in degrees of slope according to the attribute table in /mnt/c5/demimg/slope_north_slice.img: 0—5%, 6—15%, 16—30%, 31—45%, >45%.

[1] /mnt/c5/models/REVISED_ELC_ELCG_models/
[2] /mnt/c5/models/REVISED_ELC_ELCG_models/MATRIX_models_REVISED/
[3] /mnt/c5/models/REVISED_ELC_ELCG_models/MATRIX_models_REVISED/ see *4
[4] /mnt/c5/models/GENERAL_MODELS_83/ZonalMajority_Scan_HerbCC.gmd
[5] /mnt/c5/models/GENERAL_MODELS_83/Ecosites_from_EcositePhase.gmd

*1
The following two examples provide instances where it proved more practical to protect the respective classes from overwrites than attempt to further refine class discrimination.

/mnt/c5/models/REVISED_ELC_ELCG_models/8_PLUS_trans_COND.gmd

```
#protect 854 from overwrite ($n39_2923_rev == 2923 && $n33_854_rev != 854) 2923,
```

```
#protect 2923 from overwrite ($n29_841_rev == 841 and $n39_2923_rev != 2923) 841,
```

/mnt/c5/models/REVISED_ELC_ELCG_models/9_PLUS_trans_COND.gmd

```
#protect 2854 from overwrite ($n8_943_rev == 943 && $n19_2854_rev != 2854) 943,
```

*2
The INDEX operation, according to the ERDAS Imagine on—line documentation, "enables you to create a composite .img file by adding together the class values of two 'weighted' input raster files." In effect or rather in the case referred to here the 'proposed' Current_EcositePhase.img has an attribute table consisting of 75 entries viz. 0—74 of which 1—74 contain values of particular interest by recoding ('weighting') the histogram entry of the Herbaceous_Clearcuts.img to 100 and indexing these two files, the result is an EcositePhase_HerbCC_Index.img which contains the 75 entries from the 'proposed' Current_EcositePhase.img, 25 entries of 0 histogram values and an entry at row 100 of all the histogram values from the Herbaceous_Clearcuts.img.

*3
A Zonal Majority Scan according to the ERDAS Imagine on—line documentation, "Returns the most commonly occurring value in focal window <focus> around pixel of <raster>." Put another way, this operation finds every cell numbered 100 (i.e., all the Herbaceous_Clearcuts.img values), looks around each of them for 20 cells in vertical and horizontal directions and returns the most commonly occurring value it finds to the cell it has been scanning from. Specifically:

```
FOCAL MAJORITY (

$n2_EcositePhase_TOTAL_HerbCC_INDEX ,

$n4_Custom_Integer ,

IGNORE_VALUE {0, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94,
95, 96, 97, 98, 99, 100} ,

APPLY_AT_VALUE 100)
```

*4
The export histogram of the resulting MATRIX operations requires some particular attention if the table it is meant to inform is to be formatted properly. It bears repeating that these nawk program files only process the specific output files they refer to, (i.e., xxx_command_line_nsr7 ONLY processes the output of 7_Matrix_complete_working.gmd and so forth).

The following are comment headers from the nawk program files:

```
#EXERCISE CAUTION WHEN EXPORTING THE .DAT FILE
#DO NOT SELECT THE "0" ROW FOR EXPORT
#THE EXPORTED .DAT FILE !!MUST!! BE 17600 LINES
#THE EXPORTED .DAT FILE MUST BE NAMED as_sl_de_mo_nn.dat
#(Where nn represents the NSR number of the Matrix model)
#THE xxx_class_names_short FILE MUST BE APPENDED AT ROW 17601
```

Natural Sub Region List

7	Alpine
8	Subalpine
9	Montane
14	Foothills Parkland
18	Foothills Fescue

Due to conflicts between the NSR numbering scheme, legacy versions of some Ecosite Phase models and the indexing system used in the Field Guide, the following exceptions should be noted. In the following four regions, the correspondence between the Ecosite Phase Number and NSR numbering scheme DOES NOT APPLY! Regardless of these exceptions, the Ecosite Phase Number accurately indexes the Field Guide.

28	Transitional Montane
29	Transitional Subalpine
39	Foothills Parkland
49	Foothills Fescue

OUTLINE OF THE DERIVATION OF THE ECOSITES MAP

The preparation of the Ecosites.img file requires as an input the Current_EcositePhase.img.

The idea behind the derivation of the Ecosites.img file is to use the Ecosite Phase (the vegetative expression of an Ecosite) as diagnostic of its associated Ecosite.

The model [1] which produces the Ecosites.img file operates upon the Current_EcositePhase.img 'Class_Names' column by accumulating cells based on their Ecosite Phase Number, which is part of the Class_Name attribute (see Ecosite Phase List). As noted in the Outline of the Derivation of the Ecosite Phase Map, each (Ecosite Phase) model was numbered in a manner consistent (with considerations noted in the Natural Sub Region List) with the indexing system utilized in the reference document: Field Guide to Ecosites of Southwestern Alberta. The outputs of each model were numbered with this Ecosite Phase Number. So, for example, the model would aggregate cells in the following manner:

SPRUCE/HEATHER Se NORTH (841) SPRUCE/HEATHER Hc (842) — would be reclassed as Ecosite type 84

FALSE AZALEA/THIMBLEBERRY Pl (851) FALSE AZALEA/GROUSEBERRY WHITEBARK PINE (852) FALSE AZALEA/THIMBLEBERRY Se NORTH (853) FALSE AZALEA/THIMBLEBERRY Fa (854) FALSE AZALEA Hc (855) TM—FALSE AZALEA/THIMBLEBERRY Fa (2854) — would be reclassed as Ecosite type 85

HORSETAIL Se (881) — would be reclassed as Ecosite type 88

[1] /mnt/c5/models/GENERAL_MODELS_83/Ecosites_from_EcositePhase.gmd

```
CONDITIONAL {

("*81*" MATCHES $n1_PROMPT_USER."Class_Names" && NOT ("*88*" MATCHES
$n1_PROMPT_USER."Class_Names")) 1,

("*82*" MATCHES $n1_PROMPT_USER."Class_Names") 2, ("*83*" MATCHES
$n1_PROMPT_USER."Class_Names") 3, ("*84*" MATCHES
$n1_PROMPT_USER."Class_Names") 4, ("*85*" MATCHES
$n1_PROMPT_USER."Class_Names") 5, ("*88*" MATCHES
$n1_PROMPT_USER."Class_Names" && NOT ("*811*" MATCHES
$n1_PROMPT_USER."Class_Names")) 6,

("*91*" MATCHES $n1_PROMPT_USER."Class_Names") 7, ("*92*" MATCHES
$n1_PROMPT_USER."Class_Names") 8,

("*93*" MATCHES $n1_PROMPT_USER."Class_Names" && NOT (("*1934*" MATCHES
$n1_PROMPT_USER."Class_Names") || ("*1935*" MATCHES
$n1_PROMPT_USER."Class_Names") || ("*1936*" MATCHES
$n1_PROMPT_USER."Class_Names") || ("*1937*" MATCHES
$n1_PROMPT_USER."Class_Names"))) 9,

("*94*" MATCHES $n1_PROMPT_USER."Class_Names") 10, ("*95*" MATCHES
$n1_PROMPT_USER."Class_Names") 11, ("*96*" MATCHES
$n1_PROMPT_USER."Class_Names") 12, ("*97*" MATCHES
$n1_PROMPT_USER."Class_Names") 13,
("*1400*" MATCHES $n1_PROMPT_USER."Class_Names") 14, ("*1402*" MATCHES
$n1_PROMPT_USER."Class_Names") 15, ("*1403*" MATCHES
$n1_PROMPT_USER."Class_Names") 16, ("*1404*" MATCHES
$n1_PROMPT_USER."Class_Names") 17, ("*1406*" MATCHES
$n1_PROMPT_USER."Class_Names") 18, ("*1407*" MATCHES
$n1_PROMPT_USER."Class_Names") 19, ("*1408*" MATCHES
$n1_PROMPT_USER."Class_Names") 20, ("*1409*" MATCHES
$n1_PROMPT_USER."Class_Names") 21, ("*1410*" MATCHES
$n1_PROMPT_USER."Class_Names") 22, ("*1411*" MATCHES
$n1_PROMPT_USER."Class_Names") 23, ("*1412*" MATCHES
$n1_PROMPT_USER."Class_Names") 24, ("*1413*" MATCHES
$n1_PROMPT_USER."Class_Names") 25, ("*1433*" MATCHES
$n1_PROMPT_USER."Class_Names") 26,

("*1934*" MATCHES $n1_PROMPT_USER."Class_Names") 27, ("*1935*" MATCHES
$n1_PROMPT_USER."Class_Names") 28, ("*1936*" MATCHES
$n1_PROMPT_USER."Class_Names") 29, ("*1937*" MATCHES
$n1_PROMPT_USER."Class_Names") 30

}
```

Ecosite Phase Classification Detailed Methods and Conditional Statements:

This file contains a complete listing of the conditional criteria for the SUBALPINE, MONTANE, TRANSITIONAL SUBALPINE, TRANSITIONAL MONTANE, GRASSLANDS, FOOTHILLS PARKLAND and FOOTHILLS FESCUE regions in Study Area C5 [north].

These criteria were revised by Harry Archibald (April 7, 1997).

Revised April 28, 1997.
Revised June 19, 1997.

```
# # # # # # # # # # # # # # # # # # # # # # # # # # # # # # # # # # # # # # # # # # # # # # # # #
SUBALPINE 800 SERIES
# # # # # # # # # # # # # # # # # # # # # # # # # # # # # # # # # # # # # # # # # # # # # # # # #

The criteria: LICHEN LODGEPOLE PINE (811)
FORESTCOVER     ==    1          [Pine]
NATSUBREG       ==    8          [Subalpine]
DENSITY         ==    "A"        [6-30% crown closure]
------------------------------------------------------------------
The criteria: BEARBERRY/HAIRY WILD RYE LODGEPOLE PINE (821)
FORESTCOVER     ==    1 or 15    [Pine, Mixed Conifer (Pine)]
NATSUBREG       ==    8          [Subalpine]
DENSITY         !=    "A"        [DENSITY = B, C, D]
SLOPE%          >=    3          [slope 16-100%]
ASPECT          ==    2          [South]
------------------------------------------------------------------
The criteria: FALSE AZALEA/THIMBLEBERRY PI (851)
FORESTCOVER     ==    1 or 15    [Pine, Mixed Conifer (Pine)]
NATSUBREG       ==    8          [Subalpine]
DENSITY         !=    "A"        [DENSITY = B, C, D]
SLOPE%          <     3          [slope 0-15%]
ASPECT          ==    2          [South]
                           OR
FORESTCOVER     ==    1 or 15    [Pine, Mixed Conifer (Pine)]
NATSUBREG       ==    8          [Subalpine]
DENSITY         !=    "A"        [DENSITY = B, C, D]
SLOPE%          >=    1          [any slope]
ASPECT          ==    1          [North]
------------------------------------------------------------------
The criteria: FALSE AZALEA/GROUSEBERRY WHITEBARK PINE (852)
FORESTCOVER     ==    6          [Whitebark/Limber Pine]
NATSUBREG       ==    8          [Subalpine]
DENSITY         !=    "Z"        [DENSITY = A, B, C, D]
ASPECT          ==    1          [North]
```

OR

FORESTCOVER	==	6	[Whitebark/Limber Pine]
NATSUBREG	==	8	[Subalpine]
DENSITY	!=	"A"	[DENSITY = B, C, D]
ASPECT	==	2	[South]

OR

FORESTCOVER	==	19	[Mixed Conifer (Whitebark/Limber Pine)]
NATSUBREG	==	8	[Subalpine]
DENSITY	!=	"Z"	[DENSITY = A, B, C, D]
ASPECT	==	1	[North]

OR

FORESTCOVER	==	19	[Mixed Conifer (Whitebark/Limber Pine)]
NATSUBREG	==	8	[Subalpine]
DENSITY	!=	"A"	[DENSITY = B,C,D]
ASPECT	==	2	[South]

The criteria: SPRUCE/HEATHER Se NORTH (841)

FORESTCOVER == 2 or 3 or 13 or 16 or 17

[Spruce, Subalpine Fir, Subalpine Fir Mixedwood, Mixed Conifer (Spruce), Mixed Conifer (True Fir)]

NATSUBREG	==	8	[Subalpine]
LAND1	!=	"F"	[any PM except Fluvial]
ELEV	>=	1900	[elevs >= 1900 metres]

The criteria: FALSE AZALEA/THIMBLEBERRY Se NORTH (853)

FORESTCOVER	==	2 or 16	[Spruce, Mixed Conifer (Spruce)]
NATSUBREG	==	8	[Subalpine]
LAND1	!=	"F"	[any PM except Fluvial]
ELEV	<	1900	[elevs < 1900 metres]

The criteria: HORSETAIL Se (881)

FORESTCOVER	==	2 or 16	[Spruce, Mixed Conifer (Spruce)]
NATSUBREG	==	8	[Subalpine]
LAND1	==	"F"	[Fluvial]

OR

FORESTCOVER	==	21	[Spruce Wetland]
NATSUBREG	==	8	[Subalpine]
LAND1	!=	"Z"	[any PM]

The criteria: FALSE AZALEA/THIMBLEBERRY Fa (854)

FORESTCOVER == 3 or 13 or 17

[Subalpine Fir, Subalpine Fir Mixedwood, Mixed Conifer (True Fir)]

NATSUBREG	==	8	[Subalpine]
ELEV	<	1900	[elevs < 1900 metres]

```
The criteria: SUBALPINE LARCH/HEATHER La-Fa (831)
FORESTCOVER        ==    5 or 20       [Subalpine Larch, Mixed Conifer (Larch)]
NATSUBREG          ==    8             [Subalpine]
----------------------------------------------------------------------

##################################################
MONTANE 900 SERIES
##################################################

The criteria: LIMBER PINE/JUNIPER Fd-Pf (911)
FORESTCOVER        ==    4 or 6 or 18 or 19
[Douglas Fir, Whitebark/Limber Pine, Mixed Conifer (Douglas Fir),
Mixed Conifer (Whitebark/Limber Pine)]
NATSUBREG          ==    9             [Montane]
DENSITY            ==    "A"           [6-30% crown closure]
LAND1              !=    "Z"           [any PM]
ASPECT             ==    2             [South]
                               OR
FORESTCOVER        ==    1 4           [Douglas Fir Mixedwood]
NATSUBREG          ==    9             [Montane]
DENSITY            ==    "A"           [6-30% crown closure]
LAND1              !=    "GF"          [any PM except GF]
ASPECT             ==    2             [South]
----------------------------------------------------------------------
The criteria: BEARBERRY LODGEPOLE PINE (921)
FORESTCOVER        ==    1 or 15       [Pine, Mixed Conifer (Pine)]
NATSUBREG          ==    9             [Montane]
LAND1              !=    "Z"           [any PM]
ASPECT             ==    2             [South]
                               OR
FORESTCOVER        ==    1 or 15       [Pine, Mixed Conifer (Pine)]
NATSUBREG          ==    9             [Montane]
LAND1              ==    "F" or "GF"   [Fluvial or Glacial/Fluvial]
ASPECT             >=    1             [North or South]
----------------------------------------------------------------------
The criteria: BEARBERRY ASPEN (922)
FORESTCOVER        ==    7             [Aspen]
NATSUBREG          ==    9             [Montane]
LAND1              !=    "Z"           [any PM]
ASPECT             ==    2             [South]
                               OR
FORESTCOVER        ==    7             [Aspen]
NATSUBREG          ==    9             [Montane]
LAND1              ==    "F" or "GF"   [Fluvial or Glacial/Fluvial]
ASPECT             >=    1             [North or South]
```

The criteria: BEARBERRY Aw—Sw—Pl (923)

FORESTCOVER	==	9 or 11 or 13	
[Aspen Mixedwood, Pine Mixedwood, Subalpine Fir Mixedwood]			
NATSUBREG	==	9	[Montane]
DENSITY	!=	"Z"	[DENSITY = A, B, C, D]
LAND1	!=	"Z"	[any PM]
ASPECT	==	2	[South]
		OR	
FORESTCOVER	==	12	[Spruce Mixedwood]
NATSUBREG	==	9	[Montane]
LAND1	!=	"F"	[any PM except "F"]
ASPECT	==	2	[South]
		OR	
FORESTCOVER	==	14	[Douglas Fir Mixedwood]
NATSUBREG	==	9	[Montane]
DENSITY	!=	"A"	[DENSITY = B, C, D]
LAND1	!=	"Z"	[any PM]
ASPECT	==	2	[South]
		OR	
FORESTCOVER	==	9 or 11 or 12 or 13 or 14	
[Aspen Mixedwood, Pine Mixedwood, Spruce Mixedwood, Subalpine Fir Mixedwood, Douglas Fir Mixedwood]			
NATSUBREG	==	9	[Montane]
DENSITY	!=	"Z"	[DENSITY = A, B, C, D]
LAND1	==	"GF"	[Glacial/Fluvial]
ASPECT	>=	1	[North or South]

The criteria: BUFFALOBERRY HAIRY WILD RYE Fd (931)

CLASS_NAMES	==	4 or 18	[Douglas Fir, Mixed Conifer (Douglas Fir)]
NATSUBREG	==	9	[Montane]
DENSITY	!=	"A"	[DENSITY = B, C, D]
CLASS_NAMES	==	2	[South]

The criteria: CREEPING MAHONIA WHITE MEADOWSWEET Fd (941)

FORESTCOVER	==	4 or 18	[Douglas Fir, Mixed Conifer (Douglas Fir)]
NATSUBREG	==	9	[Montane]
LAND1	!=	"Z"	[any PM]
ASPECT	==	1	[North]
		OR	
FORESTCOVER	==	14	[Douglas Fir Mixedwood]
NATSUBREG	==	9	[Montane]
LAND1	!=	"GF"	[any PM except "GF"]
ASPECT	==	1	[North]

The criteria: CREEPING MAHONIA WHITE MEADOWSWEET Pl (942)

FORESTCOVER == 1 or 15 [Pine, Mixed Conifer (Pine)]
NATSUBREG == 9 [Montane]
LAND1 != "F" or "GF" [any PM except "F" or "GF"]
ASPECT == 1 [North]

OR

FORESTCOVER == 11 [Pine Mixedwood]
NATSUBREG == 9 [Montane]
LAND1 != "GF" [any PM except "GF"]
ASPECT == 1 [North]

The criteria: CREEPING MAHONIA WHITE MEADOWSWEET Sw (943)

FORESTCOVER == 2 or 16 [Spruce, Mixed Conifer (Spruce)]
NATSUBREG == 9 [Montane]
LAND1 != "F" [any PM except "F"]
ASPECT >= 1 [North or South]

OR

FORESTCOVER == 12 [Spruce Mixedwood]
NATSUBREG == 9 [Montane]
LAND1 != "F" or "GF" [any PM except "F" or "GF"]
ASPECT >= 1 [North]

OR

FORESTCOVER == 3 [Subalpine Fir]
NATSUBREG == 9 [Montane]
LAND1 != "Z" [any PM]
ASPECT == 1 [North]

The criteria: THIMBLEBERRY PINE GRASS Aw (952)

FORESTCOVER == 7 [Aspen]
NATSUBREG == 9 [Montane]
LAND1 != "F" or "GF" [any PM except "F" or "GF"]
ASPECT == 1 [North]

OR

FORESTCOVER == 9 [Aspen Mixedwood]
NATSUBREG == 9 [Montane]
LAND1 != "GF" [any PM except "GF"]
ASPECT == 1 [North]

The criteria: BALSAM POPLAR (961)

FORESTCOVER == 8 or 10 [Balsam Poplar, Balsam Poplar Mixedwood]
NATSUBREG == 9 [Montane]
LAND1 != "F" [any PM1 except"F"]

```
The criteria: HORSETAIL Sw-Pb (971)
FORESTCOVER      ==    8 or 10 or 12
[Balsam Poplar, Balsam Poplar Mixedwood, Spruce Mixedwood]
NATSUBREG        ==    9             [Montane]
LAND1            ==    "F"           [Fluvial]
----------------------------------------------------------------
The criteria: HORSETAIL Sw (972)
FORESTCOVER      ==    2 or 16       [Spruce, Mixed Conifer (Spruce)]
NATSUBREG        ==    9             [Montane]
LAND1            ==    "F"           [Fluvial]
                              OR
FORESTCOVER      ==    21            [Spruce Wetland]
NATSUBREG        ==    9             [Montane]
LAND1            !=    "Z"           [any PM]
----------------------------------------------------------------
Subalpine Larch
----------------------------------------------------------------
Mixed Conifer (Larch)
----------------------------------------------------------------
Spruce Wetland
----------------------------------------------------------------

################################################
GRASSLAND 1400 SERIES
################################################

The criteria: ROUGH FESCUE Parkland (1400)
FORESTCOVER      ==    23            [Shrub Meadow Open Mesic
                       24            Shrub Meadow Open Dry
                       27            Rough Pasture Open Mesic
                       28            Rough Pasture Open Dry
                       34            Grassland Mesic
                       35            Grassland Dry
NATSUBREG        ==    14            [Foothills Parkland]
SLOPE_POSITION   >=    2 or 3 or 4   [Incised Valleys and Valley Edges or Slopes
                                     OR Flat Valley Bottoms]
SLOPE%           <     5             [0-44% Slope]
----------------------------------------------------------------
The criteria: WILLOW GROVELAND (1402)
CLASS_NAMES      ==    25            [Shrub Meadow Closed Mesic
                       26            Shrub Meadow Closed Dry
                       29            Rough Pasture Closed Mesic
                       30            Rough Pasture Closed Dry]
NATSUBREG        ==    14 or 18      [Foothills Parkland, Foothills Fescue]
----------------------------------------------------------------
```

The criteria: WET SEDGE MEADOW (1403)

FORESTCOVER	==	31	[Wet Graminoid]
NATSUBREG	==	8, 9, 14, 18	

[Alpine, Subalpine, Montane, Foothills Parkland, Foothills Fescue]

The criteria: DRY WILLOW Montane (1404)

FORESTCOVER	==	25	[Shrub Meadow Closed Mesic
		26	Shrub Meadow Closed Dry
		29	Rough Pasture Closed Mesic
		30	Rough Pasture Closed Dry]
NATSUBREG	==	9	[Montane]

The criteria: WET WILLOW (1406)

FORESTCOVER	==	22	[Shrub Wetland]
NATSUBREG	==	8, 9, 14, 18	

[Alpine, Subalpine, Montane, Foothills Parkland, Foothills Fescue]

The criteria: DRY WILLOW Subalpine (1407)

FORESTCOVER	==	25	[Shrub Meadow Closed Mesic
		26	Shrub Meadow Closed Dry
		29	Rough Pasture Closed Mesic
		30	Rough Pasture Closed Dry]
NATSUBREG	==	8	[Subalpine]

The criteria: ROUGH FESCUE Subalpine (1408)

FORESTCOVER	==	23	[Shrub Meadow Open Mesic
		24	Shrub Meadow Open Dry
		27	Rough Pasture Open Mesic
		28	Rough Pasture Open Dry
		34	Grassland Mesic
		35	Grassland Dry
NATSUBREG	==	8	[Subalpine]
SLOPE_POSITION	>=	2	[Incised Valleys and Valley Edges or Slopes or Flat Valley Bottoms
SLOPE%	<	5	[0—44% Slope]

The criteria: STEEP HAIRY WILD RYE Subalpine (1409)

FORESTCOVER	==	23	[Shrub Meadow Open Mesic
		24	Shrub Meadow Open Dry
		27	Rough Pasture Open Mesic
		28	Rough Pasture Open Dry
		34	Grassland Mesic
		35	Grassland Dry
NATSUBREG	==	8	[Subalpine]

SLOPE_POSITION	>=	2	[Incised Valleys and Valley Edges or Slopes or Flat Valley Bottoms
SLOPE%	==	5	[>45% Slope]
ASPECT	>=3 and <=7		[E,SE, S, SW, W]

The criteria: WINDSWEPT RIDGES Subalpine (1410)

FORESTCOVER	==	23	[Shrub Meadow Open Mesic
		24	Shrub Meadow Open Dry
		26	Shrub Meadow Closed Dry
		27	Rough Pasture Open Mesic
		28	Rough Pasture Open Dry
		34	Grassland Mesic
		35	Grassland Dry
NATSUBREG	==	8	[Subalpine]
SLOPE_POSITION	==	1	[Ridges and Crests]

The criteria: WINDSWEPT RIDGES Alpine (1411)

FORESTCOVER	==	34 or 35	[Grassland Mesic, Grassland Dry]
NATSUBREG	==	7	[Alpine]

The criteria: MOIST NORTH Alpine (1412)

FORESTCOVER	==	22	[Shrub Wetland
		23	Shrub Meadow Open Mesic
		24	Shrub Meadow Open Dry
		31	Wet Graminoid]
NATSUBREG	==	7	[Alpine]

The criteria: MOIST SOUTHWEST Alpine (1413)

FORESTCOVER	==	25	[Shrub Meadow Closed Mesic
		26	Shrub Meadow Closed Dry]
NATSUBREG	==	7	[Alpine]

The criteria: ROUGH FESCUE Foothills (1433)

FORESTCOVER	==	23	[Shrub Meadow Open Mesic
		24	Shrub Meadow Open Dry
		27	Rough Pasture Open Mesic
		28	Rough Pasture Open Dry
		34	Grassland Mesic
		35	Grassland Dry
NATSUBREG	==	18	[Foothills Fescue]

The criteria: ROUGH FESCUE Montane (1934)

FORESTCOVER	==	23	[Shrub Meadow Open Mesic
		24	Shrub Meadow Open Dry
		27	Rough Pasture Open Mesic
		28	Rough Pasture Open Dry
		34	Grassland Mesic
		35	Grassland Dry
NATSUBREG	==	9	[Montane]
SLOPE_POSITION	>=	2	[Incised Valleys and Valley Edges or Slopes or Flat Valley Bottoms
SLOPE%	<	5	[0—44% Slope]

The criteria: BLUE BUNCH WHEATGRASS (1935)

FORESTCOVER	==	23	[Shrub Meadow Open Mesic
		24	Shrub Meadow Open Dry
		27	Rough Pasture Open Mesic
		28	Rough Pasture Open Dry
		34	Grassland Mesic
		35	Grassland Dry]
NATSUBREG	==	9 or 14	[Montane, Fescue, Parkland]
SLOPE_POSITION	>=	2	[Incised Valleys and Valley Edges or Slopes or Flat Valley Bottoms]
SLOPE%	>=	5	[Slope >=45%]
ASPECT	>=3 and <=7		[SE, S, SW, W]

The criteria: BEARBERRY GRASSLAND (1936)

FORESTCOVER	==	23	[Shrub Meadow Open Mesic
		24	Shrub Meadow Open Dry
		27	Rough Pasture Open Mesic
		28	Rough Pasture Open Dry
		34	Grassland Mesic
		35	Grassland Dry
NATSUBREG	==	9 or 14	[Montane or Foothills Fescue]
SLOPE_POSITION	==	1	[Hilltops]

The criteria: PINEGRASS HAIRY WILD RYE (1937)

FORESTCOVER	==	23	[Shrub Meadow Open Mesic
		24	Shrub Meadow Open Dry
		27	Rough Pasture Open Mesic
		28	Rough Pasture Open Dry
		34	Grassland Mesic
		35	Grassland Dry
NATSUBREG	==	8 or 9 or 14	[Subalpine, Montane, Foothills Fescue]
SLOPE_POSITION	>=	2	[Ridges and Crests or Slopes]
ASPECT	>=1 and <=2 or ==8		[N, NE, NW]

```
##############################################
TRANSITIONAL MONTANE 2800 SERIES
##############################################

The criteria: TM—SUBALPINE LARCH/HEATHER La—Fa (2831)
FORESTCOVER        ==    5 or 20       [Subalpine Larch, Mixed Conifer (Larch)]
NATSUBREG          ==    9             [Montane]
-----------------------------------------------------------------
The criteria: TM—FALSE AZALEA/THIMBLEBERRY Fa (2854)
FORESTCOVER        ==    3 or 13 or 17
[Subalpine Fir, Subalpine Fir Mixedwood, Mixed Conifer (True Fir)]
NATSUBREG          ==    9             [Montane]
-----------------------------------------------------------------

##############################################
TRANSITIONAL SUBALPINE 2900 SERIES
##############################################

The criteria: TS—LIMBER PINE/JUNIPER Fd—Pf (2911)
FORESTCOVER        ==    4 or 6 or 14 or 18 or 19
[Douglas Fir, Whitebark/Limber Pine, Douglas Fir Mixedwood, Mixed Conifer (Douglas Fir), Mixed
Conifer (Whitebark/Limber Pine)]
NATSUBREG          ==    8             [Subalpine]
DENSITY            ==    "A"           [6—30% crown closure]
ASPECT             ==    2             [South]
-----------------------------------------------------------------
The criteria: TS—BEARBERRY ASPEN (2922)
FORESTCOVER        ==    7             [Aspen]
NATSUBREG          ==    8             [Subalpine]
LAND1              ==    "F" or "GF"   [Fluvial or Glacial/Fluvial]
ASPECT             >=    1             [North or South]
                            OR
FORESTCOVER        ==    7             [Aspen]
NATSUBREG          ==    8             [Subalpine]
LAND1              !=    "Z"           [any PM]
ASPECT             ==    2             [South]
-----------------------------------------------------------------
The criteria: TS—BEARBERRY Aw—Sw—Pl (2923)
FORESTCOVER        ==    9 or 11 or 13
[Aspen Mixedwood, Pine Mixedwood, Subalpine Fir Mixedwood]
NATSUBREG          ==    8             [Subalpine]
LAND1              !=    "Z"           [any PM]
ASPECT             ==    2             [South]
```

```
                                   OR
FORESTCOVER         ==    1 2           [Spruce Mixedwood]
NATSUBREG           ==    8             [Subalpine]
LAND1               !=    "F"           [any PM except Fluvial]
ASPECT              ==    2             [South]
-----------------------------------------------------------------
The criteria: TS—BUFFALOBERRY HAIRY WILD RYE Fd (2931)
FORESTCOVER         ==    4 or 18       [Douglas Fir, Mixed Conifer (Douglas Fir)]
NATSUBREG           ==    8             [Subalpine]
DENSITY             !=    "A"           [DENSITY = B,C,D]
ASPECT              ==    2             [South]
-----------------------------------------------------------------
The criteria: TS—CANADA BUFFALOBERRY/HAIRY WILD RYE Aw—Sw—Pl—Fd (2934)
FORESTCOVER         ==    1 1           [Pine Mixedwood]
NATSUBREG           ==    8             [Subalpine]
DENSITY             !=    "Z"           [DENSITY = A, B, C, D]
ASPECT              ==    1             [North]
                                   OR
FORESTCOVER         ==    1 4           [Douglas Fir Mixedwood]
NATSUBREG           ==    8             [Subalpine]
DENSITY             !=    "A"           [DENSITY = B, C, D]
ASPECT              ==    2             [South]
-----------------------------------------------------------------
The criteria: TS—CREEPING MAHONIA WHITE MEADOWSWEET Fd (2941)
FORESTCOVER         ==    4 or 14 or 18
[Douglas Fir, Douglas Fir Mixedwood, Mixed Conifer (Douglas Fir)]
NATSUBREG           ==    8             [Subalpine]
ASPECT              ==    1             [North]
-----------------------------------------------------------------
The criteria: TS—CREEPING MAHONIA WHITE MEADOWSWEET Sw (2943)
FORESTCOVER         ==    1 2           [Spruce Mixedwood]
NATSUBREG           ==    8             [Subalpine]
LAND1               !=    "F"           [any PM except Fluvial]
ASPECT              ==    1             [North]
-----------------------------------------------------------------
The criteria: TS—THIMBLEBERRY PINE GRASS Aw (2952)
FORESTCOVER         ==    7             [Aspen]
NATSUBREG           ==    8             [Subalpine]
LAND1               !=    "F" or "GF"   [any PM except "F" or "GF"]
ASPECT              ==    1             [North]
                                   OR
FORESTCOVER         ==    9             [Aspen Mixedwood]
NATSUBREG           ==    8             [Subalpine]
LAND1               !=    "Z"           [any PM]
ASPECT              ==    1             [North]
```

```
The criteria: TS—BALSAM POPLAR (2961)
FORESTCOVER        ==     8 or 10        [Balsam Poplar, Balsam Poplar Mixedwood]
NATSUBREG          ==     8              [Subalpine]
LAND1              !=     "F"            [any PM except "F"]
-----------------------------------------------------------------
The criteria: TS—HORSETAIL Sw—Pb (2971)
FORESTCOVER        ==     8 or 10 or 12
[Balsam Poplar, Balsam Poplar Mixedwood, Spruce Mixedwood]
NATSUBREG          ==     8              [Subalpine]
LAND1              ==     "F"            [Fluvial]
-----------------------------------------------------------------

#################################################
FOOTHILLS PARKLAND 3900 SERIES
#################################################

The criteria: FP—LIMBER PINE/JUNIPER Fd—Pf (3911)
FORESTCOVER        ==     4 or 6 or 18 or 19
[Douglas Fir, Whitebark/Limber Pine, Mixed Conifer (Douglas Fir), Mixed Conifer
(Whitebark/Limber Pine)]
NATSUBREG          ==     14             [Foothills Parkland]
DENSITY            ==     "A"            [6—30% crown closure]
LAND1              !=     "Z"            [any PM]
ASPECT             ==     2              [South]
                                OR
FORESTCOVER        ==     14             [Douglas Fir Mixedwood]
NATSUBREG          ==     14             [Foothills Parkland]
DENSITY            ==     "A"            [6—30% crown closure]
LAND1              !=     "GF"           [any PM except GF]
ASPECT             ==     2              [South]
-----------------------------------------------------------------
The criteria: FP—BEARBERRY LODGEPOLE PINE (3921)
FORESTCOVER        ==     1 or 15        [Pine, Mixed Conifer (Pine)]
NATSUBREG          ==     14             [Foothills Parkland]
LAND1              !=     "Z"            [any PM]
ASPECT             ==     2              [South]
                                OR
FORESTCOVER        ==     1 or 15        [Pine, Mixed Conifer (Pine)]
NATSUBREG          ==     14             [Foothills Parkland]
LAND1              ==     "F" or "GF"    [Fluvial or Glacial/Fluvial]
ASPECT             >=     1              [North or South]
-----------------------------------------------------------------
```

The criteria: FP—BEARBERRY ASPEN (3922)
FORESTCOVER == 7 [Aspen]
NATSUBREG == 1 4 [Foothills Parkland]
LAND1 != "Z" [any PM]
ASPECT == 2 [South]

OR

FORESTCOVER == 7 [Aspen]
NATSUBREG == 1 4 [Foothills Parkland]
LAND1 == "F" or "GF" [Fluvial or Glacial/Fluvial]
ASPECT >= 1 [North or South]

The criteria: FP—BEARBERRY Aw—Sw—Pl (3923)
FORESTCOVER == 9 or 11 or 13
[Aspen Mixedwood, Pine Mixedwood, Subalpine Fir Mixedwood]
NATSUBREG == 1 4 [Foothills Parkland]
DENSITY != "Z" [DENSITY = A, B, C, D]
LAND1 != "Z" [any PM]
ASPECT == 2 [South]

OR

FORESTCOVER == 1 2 [Spruce Mixedwood]
NATSUBREG == 1 4 [Foothills Parkland]
LAND1 != "F" [any PM except "F"]
ASPECT == 2 [South]

OR

FORESTCOVER == 1 4 [Douglas Fir Mixedwood]
NATSUBREG == 1 4 [Foothills Parkland]
DENSITY != "A" [DENSITY = B, C, D]
LAND1 != "Z" [any PM]
ASPECT == 2 [South]

OR

FORESTCOVER == 9 or 11 or 12 or 13 or 14
[Aspen Mixedwood, Pine Mixedwood, Spruce Mixedwood, Subalpine Fir Mixedwood, Douglas Fir Mixedwood]
NATSUBREG == 1 4 [Foothills Parkland]
DENSITY != "Z" [DENSITY = A, B, C, D]
LAND1 == "GF" [Glacial/Fluvial]
ASPECT >= 1 [North or South]

The criteria: FP—BUFFALOBERRY HAIRY WILD RYE Fd (3931)
CLASS_NAMES == 4 or 18 [Douglas Fir, Mixed Conifer (Douglas Fir)]
NATSUBREG == 1 4 [Foothills Parkland]
DENSITY != "A" [DENSITY = B, C, D]
CLASS_NAMES == 2 [South]

The criteria: FP—CREEPING MAHONIA WHITE MEADOWSWEET Fd (3941)

FORESTCOVER	==	4 or 18	[Douglas Fir, Mixed Conifer (Douglas Fir)]
NATSUBREG	==	14	[Foothills Parkland]
LAND1	!=	"Z"	[any PM]
ASPECT	==	1	[North]
		OR	
FORESTCOVER	==	14	[Douglas Fir Mixedwood]
NATSUBREG	==	14	[Foothills Parkland]
LAND1	!=	"GF"	[any PM except "GF"]
ASPECT	==	1	[North]

The criteria: FP—CREEPING MAHONIA WHITE MEADOWSWEET Pl (3942)

FORESTCOVER	==	1 or 15	[Pine, Mixed Conifer (Pine)]
NATSUBREG	==	14	[Foothills Parkland]
LAND1	!=	"F" or "GF"	[any PM except "F" or "GF"]
ASPECT	==	1	[North]
		OR	
FORESTCOVER	==	11	[Pine Mixedwood]
NATSUBREG	==	14	[Foothills Parkland]
LAND1	!=	"GF"	[any PM except "GF"]
ASPECT	==	1	[North]

The criteria: FP—CREEPING MAHONIA WHITE MEADOWSWEET Sw (3943)

FORESTCOVER	==	2 or 16	[Spruce, Mixed Conifer (Spruce)]
NATSUBREG	==	14	[Foothills Parkland]
LAND1	!=	"F"	[any PM except "F"]
ASPECT	>=	1	[North or South]
		OR	
FORESTCOVER	==	12	[Spruce Mixedwood]
NATSUBREG	==	14	[Foothills Parkland]
LAND1	!=	"F" or "GF"	[any PM except "F" or "GF"]
ASPECT	>=	1	[North]
		OR	
FORESTCOVER	==	3	[Subalpine Fir]
NATSUBREG	==	14	[Foothills Parkland]
LAND1	!=	"Z"	[any PM]
ASPECT	==	1	[North]

The criteria: FP—THIMBLEBERRY PINE GRASS Aw (3952)

FORESTCOVER	==	7	[Aspen]
NATSUBREG	==	14	[Foothills Parkland]
LAND1	!=	"F" or "GF"	[any PM except "F" or "GF"]
ASPECT	==	1	[North]

```
                                    OR
FORESTCOVER        ==    9               [Aspen Mixedwood]
NATSUBREG          ==    14              [Foothills Parkland]
LAND1              !=    "GF"            [any PM except "GF"]
ASPECT             ==    1               [North]
-----------------------------------------------------------------
The criteria: FP-BALSAM POPLAR (3961)
FORESTCOVER        ==    8 or 10         [Balsam Poplar, Balsam Poplar Mixedwood]
NATSUBREG          ==    14              [Foothills Parkland]
LAND1              !=    "F"             [any PM1 except"F"]
-----------------------------------------------------------------
The criteria: FP-HORSETAIL Sw-Pb (3971)
FORESTCOVER        ==    8 or 10 or 12[Balsam Poplar, Balsam Poplar Mixedwood, Spruce
                                         Mixedwood]
NATSUBREG          ==    14              [Foothills Parkland]
LAND1              ==    "F"             [Fluvial]
-----------------------------------------------------------------
The criteria: FP-HORSETAIL Sw (3972)
FORESTCOVER        ==    2 or 16         [Spruce, Mixed Conifer (Spruce)]
NATSUBREG          ==    14              [Foothills Parkland]
LAND1              ==    "F"             [Fluvial]
                                    OR
FORESTCOVER        ==    21              [Spruce Wetland]
NATSUBREG          ==    14              [Foothills Parkland]
LAND1              !=    "Z"             [any PM]
-----------------------------------------------------------------
Subalpine Larch
-----------------------------------------------------------------
Mixed Conifer (Larch)
-----------------------------------------------------------------
Spruce Wetland
-----------------------------------------------------------------

##################################################
FOOTHILLS FESCUE 4900 SERIES
##################################################

The criteria: FF-LIMBER PINE/JUNIPER Fd-Pf (4911)
FORESTCOVER        ==    4 or 6 or 18 or 19
[Douglas Fir, Whitebark/Limber Pine, Mixed Conifer (Douglas Fir), Mixed Conifer
(Whitebark/Limber Pine)]
NATSUBREG          ==    18              [Foothills Fescue]
DENSITY            ==    "A"             [6-30% crown closure]
LAND1              !=    "Z"             [any PM]
ASPECT             ==    2               [South]
```

```
                                OR
FORESTCOVER     ==    14             [Douglas Fir Mixedwood]
NATSUBREG       ==    18             [Foothills Fescue]
DENSITY         ==    "A"            [6—30% crown closure]
LAND1           !=    "GF"           [any PM except GF]
ASPECT          ==    2              [South]
-------------------------------------------------------------
The criteria: FF—BEARBERRY LODGEPOLE PINE (4921)
FORESTCOVER     ==    1 or 15        [Pine, Mixed Conifer (Pine)]
NATSUBREG       ==    18             [Foothills Fescue]
LAND1           !=    "Z"            [any PM]
ASPECT          ==    2              [South]
                                OR
FORESTCOVER     ==    1 or 15        [Pine, Mixed Conifer (Pine)]
NATSUBREG       ==    18             [Foothills Fescue]
LAND1           ==    "F" or "GF"    [Fluvial or Glacial/Fluvial]
ASPECT          >=    1              [North or South]
-------------------------------------------------------------
The criteria: FF—BEARBERRY ASPEN (4922)
FORESTCOVER     ==    7              [Aspen]
NATSUBREG       ==    18             [Foothills Fescue]
LAND1           !=    "Z"            [any PM]
ASPECT          ==    2              [South]
                                OR
FORESTCOVER     ==    7              [Aspen]
NATSUBREG       ==    18             [Foothills Fescue]
LAND1           ==    "F" or "GF"    [Fluvial or Glacial/Fluvial]
ASPECT          >=    1              [North or South]
-------------------------------------------------------------
The criteria: FF—BEARBERRY Aw—Sw—Pl (4923)
FORESTCOVER     ==    9 or 11 or 13
[Aspen Mixedwood, Pine Mixedwood, Subalpine Fir Mixedwood]
NATSUBREG       ==    18             [Foothills Fescue]
DENSITY         !=    "Z"            [DENSITY = A, B, C, D]
LAND1           !=    "Z"            [any PM]
ASPECT          ==    2              [South]
                                OR
FORESTCOVER     ==    12             [Spruce Mixedwood]
NATSUBREG       ==    18             [Foothills Fescue]
LAND1           !=    "F"            [any PM except "F"]
ASPECT          ==    2              [South]
                                OR
FORESTCOVER     ==    14             [Douglas Fir Mixedwood]
NATSUBREG       ==    18             [Foothills Fescue]
DENSITY         !=    "A"            [DENSITY = B, C, D]
```

LAND1 != "Z" [any PM]
ASPECT == 2 [South]

OR

FORESTCOVER == 9 or 11 or 12 or 13 or 14
[Aspen Mixedwood, Pine Mixedwood, Spruce Mixedwood, Subalpine Fir Mixedwood, Douglas Fir Mixedwood]
NATSUBREG == 18 [Foothills Fescue]
DENSITY != "Z" [DENSITY = A, B, C, D]
LAND1 == "GF" [Glacial/Fluvial]
ASPECT >= 1 [North or South]

The criteria: FF—BUFFALOBERRY HAIRY WILD RYE Fd (4931)
CLASS_NAMES == 4 or 18 [Douglas Fir, Mixed Conifer (Douglas Fir)]
NATSUBREG == 18 [Foothills Fescue]
DENSITY != "A" [DENSITY = B, C, D]
CLASS_NAMES == 2 [South]

The criteria: FF—CREEPING MAHONIA WHITE MEADOWSWEET Fd (4941)
FORESTCOVER == 4 or 18 [Douglas Fir, Mixed Conifer (Douglas Fir)]
NATSUBREG == 18 [Foothills Fescue]
LAND1 != "Z" [any PM]
ASPECT == 1 [North]

OR

FORESTCOVER == 14 [Douglas Fir Mixedwood]
NATSUBREG == 18 [Foothills Fescue]
LAND1 != "GF" [any PM except "GF"]
ASPECT == 1 [North]

The criteria: FF—CREEPING MAHONIA WHITE MEADOWSWEET Pl (4942)
FORESTCOVER == 1 or 15 [Pine, Mixed Conifer (Pine)]
NATSUBREG == 18 [Foothills Fescue]
LAND1 != "F" or "GF" [any PM except "F" or "GF"]
ASPECT == 1 [North]

OR

FORESTCOVER == 11 [Pine Mixedwood]
NATSUBREG == 18 [Foothills Fescue]
LAND1 != "GF" [any PM except "GF"]
ASPECT == 1 [North]

The criteria: FF—CREEPING MAHONIA WHITE MEADOWSWEET Sw (4943)
FORESTCOVER == 2 or 16 [Spruce, Mixed Conifer (Spruce)]
NATSUBREG == 18 [Foothills Fescue]
LAND1 != "F" [any PM except "F"]
ASPECT >= 1 [North or South]

```
                                OR
FORESTCOVER        ==    1 2          [Spruce Mixedwood]
NATSUBREG          ==    1 8          [Foothills Fescue]
LAND1              !=    "F" or "GF"  [any PM except "F" or "GF"]
ASPECT             >=    1            [North]
                                OR
FORESTCOVER        ==    3            [Subalpine Fir]
NATSUBREG          ==    1 8          [Foothills Fescue]
LAND1              !=    "Z"          [any PM]
ASPECT             >=    1            [North or South]
                                OR
FORESTCOVER        ==    1 3          [Subalpine Fir Mixedwood]
NATSUBREG          ==    1 8          [Foothills Fescue]
LAND1              !=    "Z"          [any PM]
ASPECT             >=    1            [North or South]
```

The criteria: FF—THIMBLEBERRY PINE GRASS Aw (4952)

```
FORESTCOVER        ==    7            [Aspen]
NATSUBREG          ==    1 8          [Foothills Fescue]
LAND1              !=    "F" or "GF"  [any PM except "F" or "GF"]
ASPECT             ==    1            [North]
                                OR
FORESTCOVER        ==    9            [Aspen Mixedwood]
NATSUBREG          ==    1 8          [Foothills Fescue]
LAND1              !=    "GF"         [any PM except "GF"]
ASPECT             ==    1            [North]
```

The criteria: FF—BALSAM POPLAR (4961)

```
FORESTCOVER        ==    8 or 10      [Balsam Poplar, Balsam Poplar Mixedwood]
NATSUBREG          ==    1 8          [Foothills Fescue]
LAND1              !=    "F"          [any PM except"F"]
```

The criteria: FF—HORSETAIL Sw—Pb (4971)

```
FORESTCOVER        ==    8 or 10 or 12
[Balsam Poplar, Balsam Poplar Mixedwood, Spruce Mixedwood]
NATSUBREG          ==    1 8          [Foothills Fescue]
LAND1              ==    "F"          [Fluvial]
```

The criteria: FF—HORSETAIL Sw (4972)

```
FORESTCOVER        ==    2 or 16      [Spruce, Mixed Conifer (Spruce)]
NATSUBREG          ==    1 8          [Foothills Fescue]
LAND1              ==    "F"          [Fluvial]
```

```
                                 OR
FORESTCOVER       ==    21             [Spruce Wetland]
NATSUBREG         ==    18             [Foothills Fescue]
LAND1             !=    "Z"            [any PM]
-----------------------------------------------------------------
Subalpine Larch
-----------------------------------------------------------------
Mixed Conifer (Larch)
-----------------------------------------------------------------
Spruce Wetland
-----------------------------------------------------------------

# # #
END
# # #
```

APPENDIX 4 Ecosite by Landscape Management Unit

Alpine High Rock

Class Name	Count	%	Hectares
No Class	90,485	0	5655.312
Lichen	524	1.25	32.75
Bearberry/Hairy Wild Rye	129	0.31	8.062
Subalpine Larch/Heather	4896	11.67	306
Spruce/Heather	17,187	40.98	1074.188
False Azalea	7584	18.08	474
Limber Pine/Juniper	172	0.41	10.75
Bearberry	155	0.37	9.688
Canada Buffaloberry/Hairy Wild Rye	117	0.28	7.312
Thimbleberry/Pine Grass	94	0.22	5.875
Wetlands	32	0.08	2
Dry Willow Subalpine	501	1.19	31.312
Rough Fescue Subalpine	2525	6.02	157.812
Steep Hairy Wild Rye Subalpine	1480	3.53	92.5
Windswept Ridges Subalpine	1444	3.44	90.25
Alpine Exposed	4660	11.11	291.25
Moist Shrubland	14	0.03	0.875
Pinegrass Hairy Wild Rye	431	1.03	26.938
Total	41,945	100	2621.562

Head Water Valleys

Class Name	Count	%	Hectares
No Class	16,537	0	1033.562
Lichen	8976	1.68	561
Bearberry/Hairy Wild Rye	43,426	8.14	2714.125
Subalpine Larch/Heather	18,915	3.55	1182.188
Spruce/Heather	172,014	32.26	10,750.875
False Azalea	259,004	48.58	16,187.75
Horsetail SA	4860	0.91	303.75
Limber Pine/Juniper	101	0.02	6.312
Bearberry	1402	0.26	87.625
Canada Buffaloberry/Hairy Wild Rye	1106	0.21	69.125
Creeping Mahonia/White Meadowsweet	2167	0.41	135.438
Thimbleberry/Pine Grass	440	0.08	27.5
Horsetail MN	323	0.06	20.188
Wetlands	265	0.05	16.562
Wet Willow	683	0.13	42.688
Dry Willow Subalpine	1756	0.33	109.75
Rough Fescue Subalpine	11,081	2.08	692.562
Steep Hairy Wild Rye Subalpine	2060	0.39	128.75
Windswept Ridges Subalpine	3562	0.67	222.625
Alpine Exposed	794	0.15	49.625
Arctic Willow	3	0	0.188
Pinegrass Hairy Wild Rye	239	0.04	14.938
Total	533,177	100	33,323.562

Flathead

Class Name	Count	%	Hectares
No Class	32,764	0	2047.75
Lichen	3018	5.71	188.625
Bearberry/Hairy Wild Rye	3653	6.91	228.312
Subalpine Larch/Heather	187	0.35	11.688
Spruce/Heather	7186	13.6	449.125
False Azalea	18,405	34.82	1150.312
Bearberry	81	0.15	5.062
Canada Buffaloberry/Hairy Wild Rye	160	0.3	10
Creeping Mahonia/White Meadowsweet	1331	2.52	83.188
Thimbleberry/Pine Grass	41	0.08	2.562
Dry Willow Subalpine	4263	8.07	266.438
Rough Fescue Subalpine	1453	2.75	90.812
Steep Hairy Wild Rye Subalpine	2893	5.47	180.812
Windswept Ridges Subalpine	1375	2.6	85.938
Alpine Exposed	4219	7.98	263.688
Moist Shrubland	1712	3.24	107
Arctic Willow	1028	1.95	64.25
Pinegrass Hairy Wild Rye	1847	3.49	115.438
Total	52,852	100	3303.25

Crowsnest Pass

Class Name	Count	%	Hectares
No Class	27,160	0	1697.5
Lichen	156	0.16	9.75
Bearberry/Hairy Wild Rye	376	0.4	23.5
False Azalea	6257	6.59	391.062
Limber Pine/Juniper	1184	1.25	74
Bearberry	34,564	36.43	2160.25
Canada Buffaloberry/Hairy Wild Rye	2962	3.12	185.125
Creeping Mahonia/White Meadowsweet	26,948	28.4	1684.25
Thimbleberry/Pine Grass	1674	1.76	104.625
Horsetail MN	930	0.98	58.125
Wetlands	132	0.14	8.25
Dry Willow Montane	5957	6.28	372.312
Wet Willow	585	0.62	36.562
Rough Fescue Subalpine	25	0.03	1.562
Windswept Ridges Subalpine	6	0.01	0.375
Rough Fescue	11,341	11.95	708.812
Blue Bunch Wheatgrass	4	0	0.25
Bearberry Grassland	1775	1.87	110.938
Pinegrass Hairy Wild Rye	4	0	0.25
Total	94,880	100	5930

Middle Ridges

Class Name	Count	%	Hectares
No Class	32,655	0	2040.938
Lichen	37,318	3.26	2332.375
Bearberry/Hairy Wild Rye	173,813	15.19	10,863.312
Subalpine Larch/Heather	24,114	2.11	1507.125
Spruce/Heather	157,981	13.81	9873.812
False Azalea	525,493	45.92	32,843.312
Horsetail SA	8146	0.71	509.125
Limber Pine/Juniper	4401	0.38	275.062
Bearberry	35,465	3.1	2216.562
Canada Buffaloberry/Hairy Wild Rye	13,768	1.2	860.5
Creeping Mahonia/White Meadowsweet	16,810	1.47	1050.625
Thimbleberry/Pine Grass	5127	0.45	320.438
Balsam Poplar	173	0.02	10.812
Horsetail MN	503	0.04	31.438
Wetlands	394	0.03	24.625
Wet Willow	693	0.06	43.312
Dry Willow Subalpine	206	0.02	12.875
Rough Fescue Subalpine	42,780	3.74	2673.75
Steep Hairy Wild Rye Subalpine	32,710	2.86	2044.375
Windswept Ridges Subalpine	33,296	2.91	2081
Alpine Exposed	27,247	2.38	1702.938
Moist Shrubland	26	0	1.625
Rough Fescue	6	0	0.375
Pinegrass Hairy Wild Rye	3833	0.33	239.562
Total	1,144,303	100	71,518.938

Ironstone

Class Name	Count	%	Hectares
No Class	3847	0	240.438
Lichen	2515	1.88	157.188
Bearberry/Hairy Wild Rye	7695	5.75	480.938
Subalpine Larch/Heather	32	0.02	2
Spruce/Heather	2333	1.74	145.812
False Azalea	101,375	75.71	6335.938
Horsetail SA	318	0.24	19.875
Bearberry	2787	2.08	174.188
Canada Buffaloberry/Hairy Wild Rye	2197	1.64	137.312
Creeping Mahonia/White Meadowsweet	6108	4.56	381.75
Thimbleberry/Pine Grass	4631	3.46	289.438
Horsetail MN	144	0.11	9
Wetlands	384	0.29	24
Dry Willow Montane	25	0.02	1.562
Wet Willow	144	0.11	9
Dry Willow Subalpine	480	0.36	30
Rough Fescue Subalpine	1537	1.15	96.062
Steep Hairy Wild Rye Subalpine	251	0.19	15.688
Windswept Ridges Subalpine	664	0.5	41.5
Moist Shrubland	168	0.13	10.5
Rough Fescue	51	0.04	3.188

Bearberry Grassland	11	0.01	0.688
Pinegrass Hairy Wild Rye	51	0.04	3.188
Total	133,901	100	8368.812

Hillcrest

Class Name	Count	%	Hectares
No Class	5135	0	320.938
Lichen	2004	2.83	125.25
Bearberry/Hairy Wild Rye	8921	12.62	557.562
Spruce/Heather	1707	2.41	106.688
False Azalea	44,163	62.46	2760.188
Limber Pine/Juniper	430	0.61	26.875
Bearberry	1248	1.77	78
Canada Buffaloberry/Hairy Wild Rye	986	1.39	61.625
Creeping Mahonia/White Meadowsweet	3828	5.41	239.25
Thimbleberry/Pine Grass	1979	2.8	123.688
Dry Willow Montane	48	0.07	3
Dry Willow Subalpine	215	0.3	13.438
Rough Fescue Subalpine	1335	1.89	83.438
Steep Hairy Wild Rye Subalpine	1947	2.75	121.688
Windswept Ridges Subalpine	1733	2.45	108.312
Rough Fescue	28	0.04	1.75
Bearberry Grassland	3	0	0.188
Pinegrass Hairy Wild Rye	129	0.18	8.062
Total	70,704	100	4419

North Livingstone

Class Name	Count	%	Hectares
No Class	32,363	0	2022.688
Lichen	18,647	3.24	1165.438
Bearberry/Hairy Wild Rye	63,413	11.03	3963.312
Subalpine Larch/Heather	4439	0.77	277.438
Spruce/Heather	61,321	10.66	3832.562
False Azalea	214.298	37.27	13,393.625
Horsetail SA	843	0.15	52.688
Limber Pine/Juniper	779	0.14	48.688
Bearberry	14,125	2.46	882.812
Canada Buffaloberry/Hairy Wild Rye	12,483	2.17	780.188
Creeping Mahonia/White Meadowsweet	7260	1.26	453.75
Thimbleberry/Pine Grass	19,268	3.35	1204.25
Balsam Poplar	16,420	2.86	1026.25
Horsetail MN	425	0.07	26.562
Rough Fescue Parkland	2	0	0.125
Wetlands	726	0.13	45.375
Dry Willow Montane	1	0	0.062
Wet Willow	1343	0.23	83.938
Dry Willow Subalpine	208	0.04	13
Rough Fescue Subalpine	49,259	8.57	3078.688
Steep Hairy Wild Rye Subalpine	26,659	4.64	1666.188

Windswept Ridges Subalpine	34,352	5.97	2147
Alpine Exposed	24,300	4.23	1518.75
Rough Fescue	20	0	1.25
Blue Bunch Wheatgrass	4	0	0.25
Bearberry Grassland	4	0	0.25
Pinegrass Hairy Wild Rye	4390	0.76	274.375
Total	574,989	100	35,936.812

Livingstone Valley

Class Name	Count	%	Hectares
No Class	1824	0	114
Bearberry/Hairy Wild Rye	16	0.01	1
Subalpine Larch/Heather	3	0	0.188
False Azalea	248	0.22	15.5
Limber Pine/Juniper	38	0.03	2.375
Bearberry	36,270	31.97	2266.875
Canada Buffaloberry/Hairy Wild Rye	47	0.04	2.938
Creeping Mahonia/White Meadowsweet	47,824	42.15	2989
Thimbleberry/Pine Grass	1566	1.38	97.875
Balsam Poplar	97	0.09	6.062
Horsetail MN	6605	5.82	412.812
Wetlands	308	0.27	19.25
Dry Willow Montane	166	0.15	10.375
Wet Willow	2278	2.01	142.375
Rough Fescue Subalpine	9	0.01	0.562
Steep Hairy Wild Rye Subalpine	3	0	0.188
Windswept Ridges Subalpine	8	0.01	0.5
Rough Fescue	15,408	13.58	963
Blue Bunch Wheatgrass	328	0.29	20.5
Bearberry Grassland	2202	1.94	137.625
Pinegrass Hairy Wild Rye	25	0.02	1.562
Total	113,449	100	7090.562

South Livingstone

Class Name	Count	%	Hectares
No Class	39,342	0	2458.875
Lichen	7748	8.92	484.25
Bearberry/Hairy Wild Rye	4676	5.38	292.25
Subalpine Larch/Heather	1492	1.72	93.25
Spruce/Heather	1723	1.98	107.688
False Azalea	30,351	34.94	1896.938
Limber Pine/Juniper	2236	2.57	139.75
Bearberry	1986	2.29	124.125
Canada Buffaloberry/Hairy Wild Rye	2141	2.46	133.812
Creeping Mahonia/White Meadowsweet	14,623	16.84	913.938
Thimbleberry/Pine Grass	1991	2.29	124.438
Balsam Poplar	535	0.62	33.438
Horsetail MN	1	0	0.062
Dry Willow Montane	2	0	0.125

Dry Willow Subalpine	3602	4.15	225.125
Rough Fescue Subalpine	6628	7.63	414.25
Steep Hairy Wild Rye Subalpine	2766	3.18	172.875
Windswept Ridges Subalpine	2998	3.45	187.375
Alpine Exposed	1073	1.24	67.062
Arctic Willow	32	0.04	2
Rough Fescue	4	0	0.25
Blue Bunch Wheatgrass	1	0	0.062
Bearberry Grassland	1	0	0.062
Pinegrass Hairy Wild Rye	250	0.29	15.625
Total	86,860	100	5428.75

Beaver

Class Name	Count	%	Hectares
No Class	9544	0	596.5
Lichen	1437	1.33	89.812
Bearberry/Hairy Wild Rye	6266	5.79	391.625
False Azalea	11,982	11.08	748.875
Limber Pine/Juniper	5458	5.05	341.125
Bearberry	10,248	9.48	640.5
Canada Buffaloberry/Hairy Wild Rye	4419	4.09	276.188
Creeping Mahonia/White Meadowsweet	44,877	41.49	2804.812
Thimbleberry/Pine Grass	4919	4.55	307.438
Balsam Poplar	126	0.12	7.875
Wetlands	158	0.15	9.875
Dry Willow Montane	233	0.22	14.562
Dry Willow Subalpine	69	0.06	4.312
Rough Fescue Subalpine	4917	4.55	307.312
Steep Hairy Wild Rye Subalpine	2017	1.86	126.062
Windswept Ridges Subalpine	4106	3.8	256.625
Rough Fescue	3008	2.78	188
Blue Bunch Wheatgrass	724	0.67	45.25
Bearberry Grassland	2761	2.55	172.562
Pinegrass Hairy Wild Rye	428	0.4	26.75
Total	108,153	100	6759.562

Horseshoe Parkland

Class Name	Count	%	Hectares
No Class	338,681	0	21,167.562
Limber Pine/Juniper	186	0.03	11.625
Bearberry	65,418	8.91	4088.625
Canada Buffaloberry/Hairy Wild Rye	336	0.05	21
Creeping Mahonia/White Meadowsweet	39,282	5.35	2455.125
Thimbleberry/Pine Grass	163,552	22.29	10,222
Balsam Poplar	35,493	4.84	2218.312
Horsetail MN	7413	1.01	463.312
Rough Fescue Parkland	250,732	34.16	15,670.75
Willow Groveland	106,425	14.5	6651.562
Wetlands	105	0.01	6.562

Dry Willow Montane	1	0	0.062
Wet Willow	6314	0.86	394.625
Rough Fescue Subalpine	3	0	0.188
Steep Hairy Wild Rye Subalpine	1	0	0.062
Windswept Ridges Subalpine	2	0	0.125
Rough Fescue Foothills	15	0	0.938
Rough Fescue	7	0	0.438
Blue Bunch Wheatgrass	1280	0.17	80
Bearberry Grassland	57,270	7.8	3579.375
Pinegrass Hairy Wild Rye	63	0.01	3.938
Total	733,898	100	45,868.625

Saddle Mountain

Class Name	Count	%	Hectares
No Class	1673	0	104.562
Bearberry/Hairy Wild Rye	7	0	0.438
False Azalea	10	0	0.625
Limber Pine/Juniper	2074	0.66	129.625
Bearberry	64,099	20.51	4006.188
Canada Buffaloberry/Hairy Wild Rye	3328	1.07	208
Creeping Mahonia/White Meadowsweet	111,849	35.8	6990.562
Thimbleberry/Pine Grass	56,557	18.1	3534.812
Balsam Poplar	22,307	7.14	1394.188
Horsetail MN	6794	2.17	424.625
Rough Fescue Parkland	6	0	0.375
Willow Groveland	2	0	0.125
Wetlands	2074	0.66	129.625
Dry Willow Montane	8011	2.56	500.688
Wet Willow	4871	1.56	304.438
Rough Fescue Subalpine	6	0	0.375
Steep Hairy Wild Rye Subalpine	3	0	0.188
Windswept Ridges Subalpine	7	0	0.438
Rough Fescue	21,509	6.88	1344.312
Blue Bunch Wheatgrass	821	0.26	51.312
Bearberry Grassland	8025	2.57	501.562
Pinegrass Hairy Wild Rye	101	0.03	6.312
Total	312,461	100	19,528.812

Whaleback

Class Name	Count	%	Hectares
No Class	53,873	0	3367.062
Lichen	16	0	1
Bearberry/Hairy Wild Rye	11	0	0.688
Subalpine Larch/Heather	124	0.02	7.75
False Azalea	417	0.07	26.062
Limber Pine/Juniper	13,656	2.36	853.5
Bearberry	68,401	11.82	4275.062
Canada Buffaloberry/Hairy Wild Rye	12,319	2.13	769.938
Creeping Mahonia/White Meadowsweet	204,964	35.43	12,810.25

Thimbleberry/Pine Grass	68,971	11.92	4310.688
Balsam Poplar	14,695	2.54	918.438
Horsetail MN	2612	0.45	163.25
Rough Fescue Parkland	46	0.01	2.875
Willow Groveland	38	0.01	2.375
Wetlands	203	0.04	12.688
Dry Willow Montane	22,454	3.88	1403.375
Wet Willow	1825	0.32	114.062
Rough Fescue Subalpine	22	0	1.375
Steep Hairy Wild Rye Subalpine	4	0	0.25
Windswept Ridges Subalpine	6	0	0.375
Rough Fescue Foothills	13	0	0.812
Rough Fescue	124,440	21.51	7777.5
Blue Bunch Wheatgrass	4635	0.8	289.688
Bearberry Grassland	38,558	6.67	2409.875
Pinegrass Hairy Wild Rye	84	0.01	5.25
Total	578,514	100	36,157.125

Chapel Rock

Class Name	Count	%	Hectares
No Class	65,420	0	4088.75
False Azalea	166	0.05	10.375
Limber Pine/Juniper	789	0.22	49.312
Bearberry	21,106	6	1319.125
Canada Buffaloberry/Hairy Wild Rye	1174	0.33	73.375
Creeping Mahonia/White Meadowsweet	20,995	5.97	1312.188
Thimbleberry/Pine Grass	37,188	10.57	2324.25
Balsam Poplar	6160	1.75	385
Horsetail MN	1289	0.37	80.562
Wetlands	124	0.04	7.75
Dry Willow Montane	18,030	5.12	1126.875
Wet Willow	892	0.25	55.75
Rough Fescue Subalpine	14	0	0.875
Steep Hairy Wild Rye Subalpine	4	0	0.25
Windswept Ridges Subalpine	10	0	0.625
Rough Fescue Foothills	1076	0.31	67.25
Rough Fescue	197,631	56.16	12,351.938
Blue Bunch Wheatgrass	1131	0.32	70.688
Bearberry Grassland	43,928	12.48	2745.5
Pinegrass Hairy Wild Rye	225	0.06	14.062
Total	351,932	100	21,995.75

South Fescue

Class Name	Count	%	Hectares
No Class	188,239	0	11,764.938
Limber Pine/Juniper	198	0.07	12.375
Bearberry	2443	0.88	152.688
Canada Buffaloberry/Hairy Wild Rye	47	0.02	2.938
Creeping Mahonia/White Meadowsweet	2941	1.06	183.812

Thimbleberry/Pine Grass	2491	0.89	155.688
Balsam Poplar	2959	1.06	184.938
Horsetail MN	2017	0.72	126.062
Willow Groveland	2895	1.04	180.938
Wetlands	99	0.04	6.188
Rough Fescue Foothills	262,390	94.22	16,399.375
Total	278,480	100	17,405

Porcupine Hills

Class Name	Count	%	Hectares
No Class	67,354	0	4209.625
False Azalea	1038	0.08	64.875
Limber Pine/Juniper	47,196	3.81	2949.75
Bearberry	113,611	9.18	7100.688
Canada Buffaloberry/Hairy Wild Rye	42,773	3.46	2673.312
Creeping Mahonia/White Meadowsweet	373,562	30.18	23,347.625
Thimbleberry/Pine Grass	154,666	12.5	9666.625
Balsam Poplar	22,244	1.8	1390.25
Horsetail MN	5009	0.4	313.062
Rough Fescue Parkland	55	0	3.438
Willow Groveland	152	0.01	9.5
Dry Willow Montane	29,420	2.38	1838.75
Wet Willow	531	0.04	33.188
Rough Fescue Foothills	1511	0.12	94.438
Rough Fescue	353,006	28.52	22,062.875
Blue Bunch Wheatgrass	885	0.07	55.312
Bearberry Grassland	91,926	7.43	5745.375
Pinegrass Hairy Wild Rye	26	0	1.625
Total	1,237,611	100	77,350.688

East Ranchlands

Class Name	Count	%	Hectares
No Class	87,338	0	5458.625
Limber Pine/Juniper	29	0.01	1.812
Bearberry	1882	0.34	117.625
Canada Buffaloberry/Hairy Wild Rye	67	0.01	4.188
Creeping Mahonia/White Meadowsweet	4181	0.76	261.312
Thimbleberry/Pine Grass	8647	1.57	540.438
Balsam Poplar	6453	1.17	403.312
Willow Groveland	39,180	7.11	2448.75
Wetlands	108	0.02	6.75
Wet Willow	542	0.1	33.875
Rough Fescue Foothills	489,950	88.91	30,621.875
Bearberry Grassland	2	0	0.125
Total	551,041	100	34,440.062

APPENDIX 5 Ecosite Phase by Landscape Management Unit

Alpine High Rock

Class Name	Count	%	Hectares
No Class	90,485	0	5655.312
LICHEN LODGEPOLE PINE (811)	524	1.25	32.75
BEARBERRY/HAIRY WILD RYE LODGEPOLE PINE (821)	129	0.31	8.062
SUBALPINE LARCH/HEATHER La–Fa (831)	4896	11.67	306
SPRUCE/HEATHER Se NORTH (841)	16,912	40.32	1057
SPRUCE/HEATHER Hc (842)	279	0.67	17.438
FALSE AZALEA/THIMBLEBERRY Pl (851)	2384	5.68	149
FALSE AZALEA/GROUSEBERRY WHITEBARK PINE (852)	267	0.64	16.688
FALSE AZALEA/THIMBLEBERRY Se NORTH (853)	336	0.8	21
FALSE AZALEA/THIMBLEBERRY Fa (854)	4556	10.86	284.75
FALSE AZALEA Hc (855)	36	0.09	2.25
TS–LIMBER PINE/JUNIPER Fd–Pf (2911)	172	0.41	10.75
TS–BEARBERRY Aw–Sw–Pl (2923)	154	0.37	9.625
TS–BUFFALOBERRY/HAIRY WILD RYE Aw–Sw–Pl–Fd (2934)	117	0.28	7.312
TS–THIMBLEBERRY PINE GRASS Aw (2952)	94	0.22	5.875
BEARBERRY LODGEPOLE PINE (921)	1	0	0.062
WET SEDGE MEADOW (1403)	32	0.08	2
DRY WILLOW Subalpine (1407)	502	1.2	31.375
ROUGH FESCUE Subalpine (1408)	2525	6.02	157.812
STEEP HAIRY WILD RYE Subalpine (1409)	1480	3.53	92.5
WINDSWEPT RIDGES Subalpine (1410)	1444	3.44	90.25
WINDSWEPT RIDGES Alpine (1411)	4660	11.11	291.25
MOIST NORTH Alpine (1412)	14	0.03	0.875
PINEGRASS HAIRY WILD RYE (1937)	431	1.03	26.938
TOTAL	41,945	100	2621.562

Head Water Valleys

Class Name	Count	%	Hectares
No Class	16,537	0	1033.562
LICHEN LODGEPOLE PINE (811)	8804	1.65	550.25
LICHEN LODGEPOLE PINE Hc (812)	173	0.03	10.812
BEARBERRY/HAIRY WILD RYE LODGEPOLE PINE (821)	41,247	7.74	2577.938
BEARBERRY/HAIRY WILD RYE Hc (822)	2226	0.42	139.125
SUBALPINE LARCH/HEATHER La–Fa (831)	18,915	3.55	1182.188
SPRUCE/HEATHER Se NORTH (841)	161,678	30.32	10,104.875
SPRUCE/HEATHER Hc (842)	10,366	1.94	647.875
FALSE AZALEA/THIMBLEBERRY Pl (851)	112,819	21.16	7051.188
FALSE AZALEA/GROUSEBERRY WHITEBARK PINE (852)	1600	0.3	100
FALSE AZALEA/THIMBLEBERRY Se NORTH (853)	111,716	20.95	6982.25
FALSE AZALEA/THIMBLEBERRY Fa (854)	7889	1.48	493.062
FALSE AZALEA Hc (855)	24,888	4.67	1555.5
HORSETAIL Se (881)	4863	0.91	303.938
TS–LIMBER PINE/JUNIPER Fd–Pf (2911)	101	0.02	6.312
TS–BEARBERRY ASPEN (2922)	154	0.03	9.625
TS–BEARBERRY Aw–Sw–Pl (2923)	1232	0.23	77
TS–BUFFALOBERRY HAIRY WILD RYE Fd (2931)	8	0	0.5
TS–BUFFALOBERRY/HAIRY WILD RYE Aw–Sw–Pl–Fd (2934)	1098	0.21	68.625
TS–CREEPING MAHONIA WHITE MEADOWSWEET Fd (2941)	9	0	0.562
TS–CREEPING MAHONIA WHITE MEADOWSWEET Sw (2943)	1589	0.3	99.312
TS–CREEPING MAHONIA WHITE MEADOWSWEET Hc (2944)	555	0.1	34.688
TS–THIMBLEBERRY PINE GRASS Aw (2952)	440	0.08	27.5
TS–HORSETAIL Sw–Pb (2971)	323	0.06	20.188
BEARBERRY LODGEPOLE PINE (921)	13	0	0.812
BEARBERRY Aw–Sw–Pl (923)	1	0	0.062
CREEPING MAHONIA WHITE MEADOWSWEET Pl (942)	14	0	0.875

WET SEDGE MEADOW (1403)	265	0.05	16.562
WET WILLOW (1406)	683	0.13	42.688
DRY WILLOW Subalpine (1407)	1756	0.33	109.75
ROUGH FESCUE Subalpine (1408)	11,090	2.08	693.125
STEEP HAIRY WILD RYE Subalpine (1409)	2060	0.39	128.75
WINDSWEPT RIDGES Subalpine (1410)	3566	0.67	222.875
WINDSWEPT RIDGES Alpine (1411)	794	0.15	49.625
MOIST SOUTHWEST Alpine (1413)	3	0	0.188
PINEGRASS HAIRY WILD RYE (1937)	239	0.04	14.938
TOTAL	533,177	100	33,323.562

Flathead

Class Name	Count	%	Hectares
No Class	32,764	0	2047.75
LICHEN LODGEPOLE PINE (811)	3018	5.71	188.625
BEARBERRY/HAIRY WILD RYE LODGEPOLE PINE (821)	3645	6.9	227.812
BEARBERRY/HAIRY WILD RYE Hc (822)	12	0.02	0.75
SUBALPINE LARCH/HEATHER La—Fa (831)	187	0.35	11.688
SPRUCE/HEATHER Se NORTH (841)	7188	13.6	449.25
FALSE AZALEA/THIMBLEBERRY Pl (851)	10,734	20.31	670.875
FALSE AZALEA/THIMBLEBERRY Se NORTH (853)	2225	4.21	139.062
FALSE AZALEA/THIMBLEBERRY Fa (854)	5436	10.29	339.75
TS—BEARBERRY Aw—Sw—Pl (2923)	66	0.12	4.125
TS—BUFFALOBERRY/HAIRY WILD RYE Aw—Sw—Pl—Fd (2934)	160	0.3	10
TS—CREEPING MAHONIA WHITE MEADOWSWEET Sw (2943)	155	0.29	9.688
TS—THIMBLEBERRY PINE GRASS Aw (2952)	27	0.05	1.688
BEARBERRY LODGEPOLE PINE (921)	15	0.03	0.938
CREEPING MAHONIA WHITE MEADOWSWEET Pl (942)	1176	2.23	73.5
THIMBLEBERRY PINE GRASS Aw (952)	14	0.03	0.875
DRY WILLOW Subalpine (1407)	4263	8.07	266.438
ROUGH FESCUE Subalpine (1408)	1454	2.75	90.875
STEEP HAIRY WILD RYE Subalpine (1409)	2894	5.48	180.875
WINDSWEPT RIDGES Subalpine (1410)	1376	2.6	86
WINDSWEPT RIDGES Alpine (1411)	4219	7.98	263.688
MOIST NORTH Alpine (1412)	1713	3.24	107.062
MOIST SOUTHWEST Alpine (1413)	1028	1.95	64.25
PINEGRASS HAIRY WILD RYE (1937)	1847	3.49	115.438
TOTAL	52,852	100	3303.25

Crowsnest Pass

Class Name	Count	%	Hectares
No Class	27,160	0	1697.5
LICHEN LODGEPOLE PINE (811)	154	0.16	9.625
LICHEN LODGEPOLE PINE Hc (812)	2	0	0.125
BEARBERRY/HAIRY WILD RYE LODGEPOLE PINE (821)	378	0.4	23.625
FALSE AZALEA/THIMBLEBERRY Pl (851)	2884	3.04	180.25
FALSE AZALEA/THIMBLEBERRY Se NORTH (853)	446	0.47	27.875
FALSE AZALEA/THIMBLEBERRY Fa (854)	1	0	0.062
FALSE AZALEA Hc (855)	244	0.26	15.25
TS—LIMBER PINE/JUNIPER Fd—Pf (2911)	4	0	0.25
TS—BEARBERRY ASPEN (2922)	148	0.16	9.25
TS—BEARBERRY Aw—Sw—Pl (2923)	2695	2.84	168.438
TS—BUFFALOBERRY HAIRY WILD RYE Fd (2931)	1	0	0.062
TS—BUFFALOBERRY/HAIRY WILD RYE_Aw—Sw—Pl—Fd (2934)	422	0.44	26.375
TS—CREEPING MAHONIA WHITE MEADOWSWEET Fd (2941)	96	0.1	6

TS—CREEPING MAHONIA WHITE MEADOWSWEET Sw (2943)	126	0.13	7.875
TS—THIMBLEBERRY PINE GRASS Aw (2952)	166	0.17	10.375
LIMBER PINE/JUNIPER Fd—Pf (911)	1183	1.25	73.938
BEARBERRY LODGEPOLE PINE (921)	22,738	23.97	1421.125
BEARBERRY ASPEN (922)	4280	4.51	267.5
BEARBERRY Aw—Sw—Pl (923)	3832	4.04	239.5
BEARBERRY Hc (924)	879	0.93	54.938
BUFFALOBERRY HAIRY WILD RYE Fd (931)	2484	2.62	155.25
BUFFALOBERRY HAIRY WILD RYE Hc (932)	55	0.06	3.438
CREEPING MAHONIA WHITE MEADOWSWEET Fd (941)	3224	3.4	201.5
CREEPING MAHONIA WHITE MEADOWSWEET Pl (942)	11,028	11.62	689.25
CREEPING MAHONIA WHITE MEADOWSWEET Sw (943)	11,676	12.31	729.75
CREEPING MAHONIA WHITE MEADOWSWEET Hc (944)	782	0.82	48.875
THIMBLEBERRY PINE GRASS Aw (952)	1486	1.57	92.875
THIMBLEBERRY PINE GRASS Hc (953)	19	0.02	1.188
HORSETAIL Sw (972)	930	0.98	58.125
TM—FALSE AZALEA/THIMBLEBERRY Fa (2854)	2685	2.83	167.812
WET SEDGE MEADOW (1403)	132	0.14	8.25
DRY WILLOW Montane (1404)	5958	6.28	372.375
WET WILLOW (1406)	585	0.62	36.562
ROUGH FESCUE Subalpine (1408)	25	0.03	1.562
WINDSWEPT RIDGES Subalpine (1410)	6	0.01	0.375
ROUGH FESCUE Montane (1934)	11,342	11.95	708.875
BLUE BUNCH WHEATGRASS (1935)	4	0	0.25
BEARBERRY GRASSLAND (1936)	1776	1.87	111
PINEGRASS HAIRY WILD RYE (1937)	4	0	0.25
TOTAL	94,880	100	5930

Middle Ridges

Class Name	Count	%	Hectares
No Class	32,655	0	2040.938
LICHEN LODGEPOLE PINE (811)	37,279	3.26	2329.938
LICHEN LODGEPOLE PINE Hc (812)	37	0	2.312
BEARBERRY/HAIRY WILD RYE LODGEPOLE PINE (821)	172,905	15.11	10,806.562
BEARBERRY/HAIRY WILD RYE Hc (822)	1002	0.09	62.625
SUBALPINE LARCH/HEATHER La—Fa (831)	24,114	2.11	1507.125
SPRUCE/HEATHER Se NORTH (841)	155,780	13.61	9736.25
SPRUCE/HEATHER Hc (842)	2216	0.19	138.5
FALSE AZALEA/THIMBLEBERRY Pl (851)	409,585	35.79	25,599.062
FALSE AZALEA/GROUSEBERRY WHITEBARK PINE (852)	3662	0.32	228.875
FALSE AZALEA/THIMBLEBERRY Se NORTH (853)	102,959	9	6434.938
FALSE AZALEA/THIMBLEBERRY Fa (854)	5636	0.49	352.25
FALSE AZALEA Hc (855)	3507	0.31	219.188
HORSETAIL Se (881)	8156	0.71	509.75
TS—LIMBER PINE/JUNIPER Fd—Pf (2911)	4402	0.38	275.125
TS—BEARBERRY ASPEN (2922)	8246	0.72	515.375
TS—BEARBERRY Aw—Sw—Pl (2923)	27,191	2.38	1699.438
TS—BUFFALOBERRY HAIRY WILD RYE Fd (2931)	5970	0.52	373.125
TS—BUFFALOBERRY/HAIRY WILD RYE Aw—Sw—Pl—Fd (2934)	7798	0.68	487.375
TS—CREEPING MAHONIA WHITE MEADOWSWEET Fd (2941)	13,078	1.14	817.375
TS—CREEPING MAHONIA WHITE MEADOWSWEET Sw (2943)	3691	0.32	230.688
TS—THIMBLEBERRY PINE GRASS Aw (2952)	5133	0.45	320.812
TS—BALSAM POPLAR (2961)	173	0.02	10.812
TS—HORSETAIL Sw—Pb (2971)	498	0.04	31.125
BEARBERRY LODGEPOLE PINE (921)	8	0	0.5
BEARBERRY ASPEN (922)	2	0	0.125
BEARBERRY Aw—Sw—Pl (923)	3	0	0.188
BUFFALOBERRY HAIRY WILD RYE Fd (931)	1	0	0.062
CREEPING MAHONIA WHITE MEADOWSWEET Fd (941)	3	0	0.188

CREEPING MAHONIA WHITE MEADOWSWEET Pl (942)	6	0	0.375
CREEPING MAHONIA WHITE MEADOWSWEET Sw (943)	5	0	0.312
CREEPING MAHONIA WHITE MEADOWSWEET Hc (944)	36	0	2.25
HORSETAIL Sw—Pb (971)	4	0	0.25
HORSETAIL Sw (972)	1	0	0.062
WET SEDGE MEADOW (1403)	394	0.03	24.625
WET WILLOW (1406)	693	0.06	43.312
DRY WILLOW Subalpine (1407)	206	0.02	12.875
ROUGH FESCUE Subalpine (1408)	42,789	3.74	2674.312
STEEP HAIRY WILD RYE Subalpine (1409)	32,716	2.86	2044.75
WINDSWEPT RIDGES Subalpine (1410)	33,304	2.91	2081.5
WINDSWEPT RIDGES Alpine (1411)	27,247	2.38	1702.938
MOIST NORTH Alpine (1412)	26	0	1.625
ROUGH FESCUE Montane (1934)	6	0	0.375
BEARBERRY GRASSLAND (1936)	1	0	0.062
PINEGRASS HAIRY WILD RYE (1937)	3834	0.34	239.625
TOTAL	1,144,303	100	71,518.938

Ironstone

Class Name	Count	%	Hectares
No Class	3847	0	240.438
LICHEN LODGEPOLE PINE (811)	2513	1.88	157.062
BEARBERRY/HAIRY WILD RYE LODGEPOLE PINE (821)	7698	5.75	481.125
SUBALPINE LARCH/HEATHER La—Fa (831)	32	0.02	2
SPRUCE/HEATHER Se NORTH (841)	2334	1.74	145.875
FALSE AZALEA/THIMBLEBERRY Pl (851)	75,284	56.22	4705.25
FALSE AZALEA/THIMBLEBERRY Se NORTH (853)	20,004	14.94	1250.25
FALSE AZALEA/THIMBLEBERRY Fa (854)	5432	4.06	339.5
FALSE AZALEA Hc (855)	656	0.49	41
HORSETAIL Se (881)	318	0.24	19.875
TS—BEARBERRY ASPEN (2922)	680	0.51	42.5
TS—BEARBERRY Aw—Sw—Pl (2923)	590	0.44	36.875
TS—BUFFALOBERRY/HAIRY WILD RYE Aw—Sw—Pl—Fd (2934)	2209	1.65	138.062
TS—CREEPING MAHONIA WHITE MEADOWSWEET Sw (2943)	172	0.13	10.75
TS—THIMBLEBERRY PINE GRASS Aw (2952)	4556	3.4	284.75
BEARBERRY LODGEPOLE PINE (921)	1209	0.9	75.562
BEARBERRY ASPEN (922)	60	0.04	3.75
BEARBERRY Aw—Sw—Pl (923)	239	0.18	14.938
CREEPING MAHONIA WHITE MEADOWSWEET Pl (942)	4976	3.72	311
CREEPING MAHONIA WHITE MEADOWSWEET Sw (943)	571	0.43	35.688
CREEPING MAHONIA WHITE MEADOWSWEET Hc (944)	381	0.28	23.812
THIMBLEBERRY PINE GRASS Aw (952)	74	0.06	4.625
HORSETAIL Sw (972)	145	0.11	9.062
WET SEDGE MEADOW (1403)	384	0.29	24
DRY WILLOW Montane (1404)	25	0.02	1.562
WET WILLOW (1406)	145	0.11	9.062
DRY WILLOW Subalpine (1407)	480	0.36	30
ROUGH FESCUE Subalpine (1408)	1537	1.15	96.062
STEEP HAIRY WILD RYE Subalpine (1409)	251	0.19	15.688
WINDSWEPT RIDGES Subalpine (1410)	665	0.5	41.562
MOIST NORTH Alpine (1412)	168	0.13	10.5
ROUGH FESCUE Montane (1934)	51	0.04	3.188
BEARBERRY GRASSLAND (1936)	11	0.01	0.688
PINEGRASS HAIRY WILD RYE (1937)	51	0.04	3.188
TOTAL	133,901	100	8368.811

Hillcrest

Class Name	Count	%	Hectares
No Class	5135	0	320.938
LICHEN LODGEPOLE PINE (811)	2004	2.83	125.25
BEARBERRY/HAIRY WILD RYE LODGEPOLE PINE (821)	8929	12.63	558.062
SPRUCE/HEATHER Se NORTH (841)	1707	2.41	106.688
FALSE AZALEA/THIMBLEBERRY Pl (851)	34,481	48.77	2155.062
FALSE AZALEA/THIMBLEBERRY Se NORTH (853)	5146	7.28	321.625
FALSE AZALEA/THIMBLEBERRY Fa (854)	4466	6.32	279.125
FALSE AZALEA Hc (855)	65	0.09	4.062
TS—LIMBER PINE/JUNIPER Fd—Pf (2911)	430	0.61	26.875
TS—BEARBERRY ASPEN (2922)	536	0.76	33.5
TS—BEARBERRY Aw—Sw—Pl (2923)	536	0.76	33.5
TS—BUFFALOBERRY HAIRY WILD RYE Fd (2931)	278	0.39	17.375
TS—BUFFALOBERRY/HAIRY WILD RYE Aw—Sw—Pl—Fd (2934)	693	0.98	43.312
TS—CREEPING MAHONIA WHITE MEADOWSWEET Fd (2941)	3425	4.84	214.062
TS—CREEPING MAHONIA WHITE MEADOWSWEET Sw (2943)	15	0.02	0.938
TS—THIMBLEBERRY PINE GRASS Aw (2952)	1961	2.77	122.562
BEARBERRY LODGEPOLE PINE (921)	163	0.23	10.188
BEARBERRY Aw—Sw—Pl (923)	11	0.02	0.688
BUFFALOBERRY HAIRY WILD RYE Fd (931)	8	0.01	0.5
CREEPING MAHONIA WHITE MEADOWSWEET Fd (941)	152	0.21	9.5
CREEPING MAHONIA WHITE MEADOWSWEET Pl (942)	157	0.22	9.812
CREEPING MAHONIA WHITE MEADOWSWEET Sw (943)	76	0.11	4.75
CREEPING MAHONIA WHITE MEADOWSWEET Hc (944)	4	0.01	0.25
THIMBLEBERRY PINE GRASS Aw (952)	13	0.02	0.812
TM—FALSE AZALEA/THIMBLEBERRY Fa (2854)	4	0.01	0.25
DRY WILLOW Montane (1404)	53	0.07	3.312
DRY WILLOW Subalpine (1407)	215	0.3	13.438
ROUGH FESCUE Subalpine (1408)	1336	1.89	83.5
STEEP HAIRY WILD RYE Subalpine (1409)	1947	2.75	121.688
WINDSWEPT RIDGES Subalpine (1410)	1733	2.45	108.312
ROUGH FESCUE Montane (1934)	28	0.04	1.75
BEARBERRY GRASSLAND (1936)	3	0	0.188
PINEGRASS HAIRY WILD RYE (1937)	129	0.18	8.062
TOTAL	70,704	100	4419

North Livingstone

Class Name	Count	%	Hectares
No Class	32,363	0	2022.688
LICHEN LODGEPOLE PINE (811)	18,650	3.24	1165.625
BEARBERRY/HAIRY WILD RYE LODGEPOLE PINE (821)	63,427	11.03	3964.188
BEARBERRY/HAIRY WILD RYE Hc (822)	11	0	0.688
SUBALPINE LARCH/HEATHER La—Fa (831)	4439	0.77	277.438
SPRUCE/HEATHER Se NORTH (841)	60,998	10.61	3812.375
SPRUCE/HEATHER Hc (842)	329	0.06	20.562
FALSE AZALEA/THIMBLEBERRY Pl (851)	163,712	28.47	10232
FALSE AZALEA/GROUSEBERRY WHITEBARK PINE (852)	3054	0.53	190.875
FALSE AZALEA/THIMBLEBERRY Se NORTH (853)	45,771	7.96	2860.688
FALSE AZALEA/THIMBLEBERRY Fa (854)	929	0.16	58.062
FALSE AZALEA Hc (855)	801	0.14	50.062
HORSETAIL Se (881)	843	0.15	52.688
TS—LIMBER PINE/JUNIPER Fd—Pf (2911)	779	0.14	48.688
TS—BEARBERRY ASPEN (2922)	7856	1.37	491
TS—BEARBERRY Aw—Sw—Pl (2923)	6213	1.08	388.312
TS—BUFFALOBERRY HAIRY WILD RYE Fd (2931)	684	0.12	42.75
TS—BUFFALOBERRY/HAIRY WILD RYE Aw—Sw—Pl—Fd (2934)	11,805	2.05	737.812

TS–CREEPING MAHONIA WHITE MEADOWSWEET Fd (2941)	2346	0.41	146.625
TS–CREEPING MAHONIA WHITE MEADOWSWEET Sw (2943)	4888	0.85	305.5
TS–THIMBLEBERRY PINE GRASS Aw (2952)	19,242	3.35	1202.625
TS–BALSAM POPLAR (2961)	16,404	2.85	1025.25
TS–HORSETAIL Sw–Pb (2971)	420	0.07	26.25
BEARBERRY LODGEPOLE PINE (921)	22	0	1.375
BEARBERRY ASPEN (922)	2	0	0.125
BEARBERRY Aw–Sw–Pl (923)	7	0	0.438
CREEPING MAHONIA WHITE MEADOWSWEET Fd (941)	1	0	0.062
CREEPING MAHONIA WHITE MEADOWSWEET Pl (942)	28	0	1.75
CREEPING MAHONIA WHITE MEADOWSWEET Sw (943)	7	0	0.438
THIMBLEBERRY PINE GRASS Aw (952)	5	0	0.312
BALSAM POPLAR (961)	7	0	0.438
HORSETAIL Sw–Pb (971)	3	0	0.188
HORSETAIL Sw (972)	4	0	0.25
ROUGH FESCUE Parkland (1400)	2	0	0.125
WET SEDGE MEADOW (1403)	726	0.13	45.375
DRY WILLOW Montane (1404)	1	0	0.062
WET WILLOW (1406)	1343	0.23	83.938
DRY WILLOW Subalpine (1407)	208	0.04	13
ROUGH FESCUE Subalpine (1408)	49,275	8.57	3079.688
STEEP HAIRY WILD RYE Subalpine (1409)	26,664	4.64	1666.5
WINDSWEPT RIDGES Subalpine (1410)	34,362	5.98	2147.625
WINDSWEPT RIDGES Alpine (1411)	24,300	4.23	1518.75
ROUGH FESCUE Montane (1934)	20	0	1.25
BLUE BUNCH WHEATGRASS (1935)	4	0	0.25
BEARBERRY GRASSLAND (1936)	4	0	0.25
PINEGRASS HAIRY WILD RYE (1937)	4390	0.76	274.375
PK–BEARBERRY Aw–Sw–Pl (3923)	1	0	0.062
PK–CREEPING MAHONIA WHITE MEADOWSWEET Pl (3942)	2	0	0.125
TOTAL	574,989	100	35,936.812

Livingstone Valley

Class Name	Count	%	Hectares
No Class	1824	0	114
BEARBERRY/HAIRY WILD RYE LODGEPOLE PINE (821)	19	0.02	1.188
BEARBERRY/HAIRY WILD RYE Hc (822)	6	0.01	0.375
SPRUCE/HEATHER Se NORTH (841)	3	0	0.188
FALSE AZALEA/THIMBLEBERRY Pl (851)	13	0.01	0.812
FALSE AZALEA/THIMBLEBERRY Se NORTH (853)	8	0.01	0.5
FALSE AZALEA/THIMBLEBERRY Fa (854)	2	0	0.125
FALSE AZALEA Hc (855)	167	0.15	10.438
TS–BEARBERRY Aw–Sw–Pl (2923)	2	0	0.125
TS–BUFFALOBERRY/HAIRY WILD RYE Aw–Sw–Pl–Fd (2934)	1	0	0.062
TS–CREEPING MAHONIA WHITE MEADOWSWEET Fd (2941)	1	0	0.062
TS–THIMBLEBERRY PINE GRASS Aw (2952)	2	0	0.125
LIMBER PINE/JUNIPER Fd–Pf (911)	38	0.03	2.375
BEARBERRY LODGEPOLE PINE (921)	28,494	25.12	1780.875
BEARBERRY ASPEN (922)	2067	1.82	129.188
BEARBERRY Aw–Sw–Pl (923)	5316	4.69	332.25
BEARBERRY Hc (924)	366	0.32	22.875
BUFFALOBERRY HAIRY WILD RYE Fd (931)	47	0.04	2.938
CREEPING MAHONIA WHITE MEADOWSWEET Fd (941)	45	0.04	2.812
CREEPING MAHONIA WHITE MEADOWSWEET Pl (942)	31,686	27.93	1980.375
CREEPING MAHONIA WHITE MEADOWSWEET Sw (943)	14,196	12.51	887.25
CREEPING MAHONIA WHITE MEADOWSWEET Hc (944)	1882	1.66	117.625
THIMBLEBERRY PINE GRASS Aw (952)	1470	1.3	91.875
THIMBLEBERRY PINE GRASS Hc (953)	101	0.09	6.312
BALSAM POPLAR (961)	97	0.09	6.062

HORSETAIL Sw–Pb (971)	3162	2.79	197.625
HORSETAIL Sw (972)	3439	3.03	214.938
TM–FALSE AZALEA/THIMBLEBERRY Fa (2854)	63	0.06	3.938
WET SEDGE MEADOW (1403)	308	0.27	19.25
DRY WILLOW Montane (1404)	166	0.15	10.375
WET WILLOW (1406)	2278	2.01	142.375
ROUGH FESCUE Subalpine (1408)	10	0.01	0.625
STEEP HAIRY WILD RYE Subalpine (1409)	3	0	0.188
WINDSWEPT RIDGES Subalpine (1410)	9	0.01	0.562
ROUGH FESCUE Montane (1934)	15,422	13.59	963.875
BLUE BUNCH WHEATGRASS (1935)	330	0.29	20.625
BEARBERRY GRASSLAND (1936)	2205	1.94	137.812
PINEGRASS HAIRY WILD RYE (1937)	25	0.02	1.562
TOTAL	113,449	100	7090.562

South Livingstone

Class Name	Count	%	Hectares
No Class	39,342	0	2458.875
LICHEN LODGEPOLE PINE (811)	7748	8.92	484.25
BEARBERRY/HAIRY WILD RYE LODGEPOLE PINE (821)	4680	5.39	292.5
SUBALPINE LARCH/HEATHER La–Fa (831)	1492	1.72	93.25
SPRUCE/HEATHER Se NORTH (841)	1724	1.98	107.75
FALSE AZALEA/THIMBLEBERRY Pl (851)	26,123	30.07	1632.688
FALSE AZALEA/THIMBLEBERRY Se NORTH (853)	4224	4.86	264
TS–LIMBER PINE/JUNIPER Fd–Pf (2911)	2236	2.57	139.75
TS–BEARBERRY ASPEN (2922)	463	0.53	28.938
TS–BEARBERRY Aw–Sw–Pl (2923)	1516	1.75	94.75
TS–BUFFALOBERRY HAIRY WILD RYE Fd (2931)	875	1.01	54.688
TS–BUFFALOBERRY/HAIRY WILD RYE Aw–Sw–Pl–Fd (2934)	1264	1.46	79
TS–CREEPING MAHONIA WHITE MEADOWSWEET Fd (2941)	14,297	16.46	893.562
TS–CREEPING MAHONIA WHITE MEADOWSWEET Sw (2943)	301	0.35	18.812
TS–THIMBLEBERRY PINE GRASS Aw (2952)	1991	2.29	124.438
TS–BALSAM POPLAR (2961)	534	0.61	33.375
BEARBERRY LODGEPOLE PINE (921)	2	0	0.125
BEARBERRY ASPEN (922)	1	0	0.062
BEARBERRY Aw–Sw–Pl (923)	2	0	0.125
CREEPING MAHONIA WHITE MEADOWSWEET Fd (941)	1	0	0.062
CREEPING MAHONIA WHITE MEADOWSWEET Pl (942)	18	0.02	1.125
CREEPING MAHONIA WHITE MEADOWSWEET Sw (943)	7	0.01	0.438
THIMBLEBERRY PINE GRASS Aw (952)	1	0	0.062
BALSAM POPLAR (961)	1	0	0.062
HORSETAIL Sw–Pb (971)	1	0	0.062
DRY WILLOW Montane (1404)	2	0	0.125
DRY WILLOW Subalpine (1407)	3602	4.15	225.125
ROUGH FESCUE Subalpine (1408)	6629	7.63	414.312
STEEP HAIRY WILD RYE Subalpine (1409)	2766	3.18	172.875
WINDSWEPT RIDGES Subalpine (1410)	2998	3.45	187.375
WINDSWEPT RIDGES Alpine (1411)	1073	1.24	67.062
MOIST SOUTHWEST Alpine (1413)	32	0.04	2
ROUGH FESCUE Montane (1934)	4	0	0.25
BLUE BUNCH WHEATGRASS (1935)	1	0	0.062
BEARBERRY GRASSLAND (1936)	1	0	0.062
PINEGRASS HAIRY WILD RYE (1937)	250	0.29	15.625
TOTAL	86,860	100	5428.75

Beaver

Class Name	Count	%	Hectares
No Class	9544	0	596.5
LICHEN LODGEPOLE PINE (811)	1437	1.33	89.812
BEARBERRY/HAIRY WILD RYE LODGEPOLE PINE (821)	6267	5.79	391.688
FALSE AZALEA/THIMBLEBERRY Pl (851)	11,758	10.87	734.875
FALSE AZALEA/THIMBLEBERRY Se NORTH (853)	218	0.2	13.625
TS—LIMBER PINE/JUNIPER Fd—Pf (2911)	2102	1.94	131.375
TS—BEARBERRY ASPEN (2922)	1621	1.5	101.312
TS—BEARBERRY Aw—Sw—Pl (2923)	1424	1.32	89
TS—BUFFALOBERRY HAIRY WILD RYE Fd (2931)	1620	1.5	101.25
TS—BUFFALOBERRY/HAIRY WILD RYE Aw—Sw—Pl—Fd (2934)	136	0.13	8.5
TS—CREEPING MAHONIA WHITE MEADOWSWEET Fd (2941)	1558	1.44	97.375
TS—THIMBLEBERRY PINE GRASS Aw (2952)	2639	2.44	164.938
LIMBER PINE/JUNIPER Fd—Pf (911)	3368	3.11	210.5
BEARBERRY LODGEPOLE PINE (921)	4905	4.54	306.562
BEARBERRY ASPEN (922)	829	0.77	51.812
BEARBERRY Aw—Sw—Pl (923)	1468	1.36	91.75
BUFFALOBERRY HAIRY WILD RYE Fd (931)	2665	2.46	166.562
CREEPING MAHONIA WHITE MEADOWSWEET Fd (941)	14,008	12.95	875.5
CREEPING MAHONIA WHITE MEADOWSWEET Pl (942)	19,214	17.77	1200.875
CREEPING MAHONIA WHITE MEADOWSWEET Sw (943)	9364	8.66	585.25
CREEPING MAHONIA WHITE MEADOWSWEET Hc (944)	711	0.66	44.438
THIMBLEBERRY PINE GRASS Aw (952)	2274	2.1	142.125
BALSAM POPLAR (961)	126	0.12	7.875
TM—FALSE AZALEA/THIMBLEBERRY Fa (2854)	8	0.01	0.5
WET SEDGE MEADOW (1403)	158	0.15	9.875
DRY WILLOW Montane (1404)	233	0.22	14.562
DRY WILLOW Subalpine (1407)	70	0.06	4.375
ROUGH FESCUE Subalpine (1408)	4921	4.55	307.562
STEEP HAIRY WILD RYE Subalpine (1409)	2017	1.86	126.062
WINDSWEPT RIDGES Subalpine (1410)	4109	3.8	256.812
ROUGH FESCUE Montane (1934)	3009	2.78	188.062
BLUE BUNCH WHEATGRASS (1935)	725	0.67	45.312
BEARBERRY GRASSLAND (1936)	2763	2.55	172.688
PINEGRASS HAIRY WILD RYE (1937)	428	0.4	26.75
TOTAL	108,153	100	6759.562

Horseshoe Parkland

Class Name	Count	%	Hectares
No Class	338,681	0	21,167.562
FALSE AZALEA/THIMBLEBERRY Pl (851)	1	0	0.062
TS—BEARBERRY ASPEN (2922)	1	0	0.062
TS—CREEPING MAHONIA WHITE MEADOWSWEET Sw (2943)	3	0	0.188
TS—BALSAM POPLAR (2961)	2	0	0.125
BEARBERRY LODGEPOLE PINE (921)	4	0	0.25
BEARBERRY ASPEN (922)	11	0	0.688
BEARBERRY Aw—Sw—Pl (923)	6	0	0.375
CREEPING MAHONIA WHITE MEADOWSWEET Fd (941)	4	0	0.25
CREEPING MAHONIA WHITE MEADOWSWEET Pl (942)	15	0	0.938
CREEPING MAHONIA WHITE MEADOWSWEET Sw (943)	6	0	0.375
CREEPING MAHONIA WHITE MEADOWSWEET Hc (944)	15	0	0.938
THIMBLEBERRY PINE GRASS Aw (952)	10	0	0.625
BALSAM POPLAR (961)	1	0	0.062
HORSETAIL Sw—Pb (971)	1	0	0.062
ROUGH FESCUE Parkland (1400)	250,758	34.17	15,672.375
WILLOW GROVELAND (1402)	106,426	14.5	6651.625

WET SEDGE MEADOW (1403)	105	0.01	6.562
DRY WILLOW Montane (1404)	1	0	0.062
WET WILLOW (1406)	6317	0.86	394.812
ROUGH FESCUE Subalpine (1408)	4	0	0.25
STEEP HAIRY WILD RYE Subalpine (1409)	1	0	0.062
WINDSWEPT RIDGES Subalpine (1410)	2	0	0.125
ROUGH FESCUE Foothills (1433)	15	0	0.938
ROUGH FESCUE Montane (1934)	7	0	0.438
BLUE BUNCH WHEATGRASS (1935)	1282	0.17	80.125
BEARBERRY GRASSLAND (1936)	57,274	7.8	3579.625
PINEGRASS HAIRY WILD RYE (1937)	63	0.01	3.938
PK–LIMBER PINE/JUNIPER Fd–Pf (3911)	186	0.03	11.625
PK–BEARBERRY LODGEPOLE PINE (3921)	2385	0.32	149.062
PK–BEARBERRY ASPEN (3922)	55,280	7.53	3455
PK–BEARBERRY Aw–Sw–Pl (3923)	7675	1.05	479.688
PK–BUFFALOBERRY HAIRY WILD RYE–Fd (3931)	334	0.05	20.875
PK–CREEPING MAHONIA WHITE MEADOWSWEET Fd (3941)	3596	0.49	224.75
PK–CREEPING MAHONIA WHITE MEADOWSWEET Pl (3942)	5925	0.81	370.312
PK–CREEPING MAHONIA WHITE MEADOWSWEET Sw (3943)	29,686	4.04	1855.375
PK–THIMBLEBERRY PINE GRASS Aw (3952)	163,575	22.29	10,223.438
PK–BALSAM POPLAR (3961)	35,505	4.84	2219.062
PK–HORSETAIL Sw–Pb (3971)	6347	0.86	396.688
PK–HORSETAIL Sw (3972)	1065	0.15	66.562
FF–THIMBLEBERRY PINE GRASS Aw (4952)	4	0	0.25
TOTAL	733,898	100	45,868.625

Saddle Mountain

Class Name	Count	%	Hectares
No Class	1673	0	104.562
LICHEN LODGEPOLE PINE (811)	2	0	0.125
BEARBERRY/HAIRY WILD RYE LODGEPOLE PINE (821)	8	0	0.5
FALSE AZALEA/THIMBLEBERRY Pl (851)	13	0	0.812
TS–BEARBERRY ASPEN (2922)	1	0	0.062
TS–BEARBERRY Aw–Sw–Pl (2923)	1	0	0.062
TS–BUFFALOBERRY/HAIRY WILD RYE Aw–Sw–Pl–Fd (2934)	1	0	0.062
TS–THIMBLEBERRY PINE GRASS Aw (2952)	3	0	0.188
TS–BALSAM POPLAR (2961)	10	0	0.625
LIMBER PINE/JUNIPER Fd–Pf (911)	2076	0.66	129.75
BEARBERRY LODGEPOLE PINE (921)	22,540	7.21	1408.75
BEARBERRY ASPEN (922)	27,711	8.87	1731.938
BEARBERRY Aw–Sw–Pl (923)	13,366	4.28	835.375
BEARBERRY Hc (924)	291	0.09	18.188
BUFFALOBERRY HAIRY WILD RYE Fd (931)	3328	1.07	208
CREEPING MAHONIA WHITE MEADOWSWEET Fd (941)	10,221	3.27	638.812
CREEPING MAHONIA WHITE MEADOWSWEET Pl (942)	67,337	21.55	4208.562
CREEPING MAHONIA WHITE MEADOWSWEET Sw (943)	34,045	10.9	2127.812
CREEPING MAHONIA WHITE MEADOWSWEET Hc (944)	341	0.11	21.312
THIMBLEBERRY PINE GRASS Aw (952)	56,447	18.07	3527.938
THIMBLEBERRY PINE GRASS Hc (953)	127	0.04	7.938
BALSAM POPLAR (961)	22,277	7.13	1392.312
HORSETAIL Sw–Pb (971)	5052	1.62	315.75
HORSETAIL Sw (972)	1737	0.56	108.562
ROUGH FESCUE Parkland (1400)	7	0	0.438
WILLOW GROVELAND (1402)	3	0	0.188
WET SEDGE MEADOW (1403)	2075	0.66	129.688
DRY WILLOW Montane (1404)	8015	2.57	500.938
WET WILLOW (1406)	4871	1.56	304.438

ROUGH FESCUE Subalpine (1408)	6	0	0.375
STEEP HAIRY WILD RYE Subalpine (1409)	3	0	0.188
WINDSWEPT RIDGES Subalpine (1410)	9	0	0.562
ROUGH FESCUE Montane (1934)	21,524	6.89	1345.25
BLUE BUNCH WHEATGRASS (1935)	821	0.26	51.312
BEARBERRY GRASSLAND (1936)	8033	2.57	502.062
PINEGRASS HAIRY WILD RYE (1937)	101	0.03	6.312
PK—BEARBERRY LODGEPOLE PINE (3921)	1	0	0.062
PK—BEARBERRY ASPEN (3922)	1	0	0.062
PK—BEARBERRY Aw—Sw—Pl (3923)	16	0.01	1
PK—CREEPING MAHONIA WHITE MEADOWSWEET Fd (3941)	1	0	0.062
PK—CREEPING MAHONIA WHITE MEADOWSWEET Pl (3942)	6	0	0.375
PK—CREEPING MAHONIA WHITE MEADOWSWEET Sw (3943)	4	0	0.25
PK—THIMBLEBERRY PINE GRASS Aw (3952)	12	0	0.75
PK—BALSAM POPLAR (3961)	10	0	0.625
PK—HORSETAIL Sw—Pb (3971)	7	0	0.438
TOTAL	312,461	100	19,528.81

Whaleback

Class Name	Count	%	Hectares
No Class	53,873	0	3367.062
LICHEN LODGEPOLE PINE (811)	16	0	1
BEARBERRY/HAIRY WILD RYE LODGEPOLE PINE (821)	11	0	0.688
FALSE AZALEA/THIMBLEBERRY Pl (851)	75	0.01	4.688
FALSE AZALEA/THIMBLEBERRY Se NORTH (853)	19	0	1.188
TS—LIMBER PINE/JUNIPER Fd—Pf (2911)	14	0	0.875
TS—BEARBERRY ASPEN (2922)	4	0	0.25
TS—BEARBERRY Aw—Sw—Pl (2923)	1	0	0.062
TS—CREEPING MAHONIA WHITE MEADOWSWEET Fd (2941)	6	0	0.375
TS—THIMBLEBERRY PINE GRASS Aw (2952)	6	0	0.375
TS—BALSAM POPLAR (2961)	8	0	0.5
LIMBER PINE/JUNIPER Fd—Pf (911)	13,657	2.36	853.562
BEARBERRY LODGEPOLE PINE (921)	23,550	4.07	1471.875
BEARBERRY ASPEN (922)	29,852	5.16	1865.75
BEARBERRY Aw—Sw—Pl (923)	14,825	2.56	926.562
BUFFALOBERRY HAIRY WILD RYE Fd (931)	12,328	2.13	770.5
CREEPING MAHONIA WHITE MEADOWSWEET Fd (941)	97,471	16.85	6091.938
CREEPING MAHONIA WHITE MEADOWSWEET Pl (942)	78,435	13.56	4902.188
CREEPING MAHONIA WHITE MEADOWSWEET Sw (943)	29,103	5.03	1818.938
THIMBLEBERRY PINE GRASS Aw (952)	68,987	11.92	4311.688
BALSAM POPLAR (961)	14,688	2.54	918
HORSETAIL Sw—Pb (971)	2024	0.35	126.5
HORSETAIL Sw (972)	590	0.1	36.875
TM—SUBALPINE LARCH/HEATHER La—Fa (2831)	124	0.02	7.75
TM—FALSE AZALEA/THIMBLEBERRY Fa (2854)	328	0.06	20.5
ROUGH FESCUE Parkland (1400)	47	0.01	2.938
WILLOW GROVELAND (1402)	38	0.01	2.375
WET SEDGE MEADOW (1403)	203	0.04	12.688
DRY WILLOW Montane (1404)	22,454	3.88	1403.375
WET WILLOW (1406)	1825	0.32	114.062
ROUGH FESCUE Subalpine (1408)	22	0	1.375
STEEP HAIRY WILD RYE Subalpine (1409)	4	0	0.25
WINDSWEPT RIDGES Subalpine (1410)	6	0	0.375
ROUGH FESCUE Foothills (1433)	13	0	0.812
ROUGH FESCUE Montane (1934)	124,455	21.51	7778.438
BLUE BUNCH WHEATGRASS (1935)	4636	0.8	289.75
BEARBERRY GRASSLAND (1936)	38,561	6.67	2410.062

PINEGRASS HAIRY WILD RYE (1937)	84	0.01	5.25
PK–BEARBERRY ASPEN (3922)	27	0	1.688
PK–THIMBLEBERRY PINE GRASS Aw (3952)	16	0	1
FF–CREEPING MAHONIA WHITE MEADOWSWEET Fd (4941)	1	0	0.062
TOTAL	578,514	100	36,157.127

Chapel Rock

Class Name	Count	%	Hectares
No Class	65,420	0	4088.75
FALSE AZALEA/THIMBLEBERRY Pl (851)	7	0	0.438
FALSE AZALEA/THIMBLEBERRY Se NORTH (853)	7	0	0.438
TS–LIMBER PINE/JUNIPER Fd–Pf (2911)	1	0	0.062
TS–BEARBERRY ASPEN (2922)	4	0	0.25
TS–CREEPING MAHONIA WHITE MEADOWSWEET Fd (2941)	2	0	0.125
TS–THIMBLEBERRY PINE GRASS Aw (2952)	15	0	0.938
LIMBER PINE/JUNIPER Fd–Pf (911)	788	0.22	49.25
BEARBERRY LODGEPOLE PINE (921)	4994	1.42	312.125
BEARBERRY ASPEN (922)	14,674	4.17	917.125
BEARBERRY Aw–Sw–Pl (923)	1414	0.4	88.375
BUFFALOBERRY HAIRY WILD RYE Fd (931)	1174	0.33	73.375
CREEPING MAHONIA WHITE MEADOWSWEET Fd (941)	7113	2.02	444.562
CREEPING MAHONIA WHITE MEADOWSWEET Pl (942)	9300	2.64	581.25
CREEPING MAHONIA WHITE MEADOWSWEET Sw (943)	4565	1.3	285.312
THIMBLEBERRY PINE GRASS Aw (952)	37,141	10.55	2321.312
BALSAM POPLAR (961)	6148	1.75	384.25
HORSETAIL Sw–Pb (971)	1276	0.36	79.75
TM–FALSE AZALEA/THIMBLEBERRY Fa (2854)	153	0.04	9.562
WET SEDGE MEADOW (1403)	124	0.04	7.75
DRY WILLOW Montane (1404)	18,030	5.12	1126.875
WET WILLOW (1406)	892	0.25	55.75
ROUGH FESCUE Subalpine (1408)	16	0	1
STEEP HAIRY WILD RYE Subalpine (1409)	4	0	0.25
WINDSWEPT RIDGES Subalpine (1410)	10	0	0.625
ROUGH FESCUE Foothills (1433)	1077	0.31	67.312
ROUGH FESCUE Montane (1934)	197,640	56.16	12,352.5
BLUE BUNCH WHEATGRASS (1935)	1131	0.32	70.688
BEARBERRY GRASSLAND (1936)	43,936	12.48	2746
PINEGRASS HAIRY WILD RYE (1937)	225	0.06	14.062
FF–BEARBERRY ASPEN (4922)	7	0	0.438
FF–CREEPING MAHONIA WHITE MEADOWSWEET Fd (4941)	10	0	0.625
FF–CREEPING MAHONIA WHITE MEADOWSWEET Sw (4943)	4	0	0.25
FF–THIMBLEBERRY PINE GRASS Aw (4952)	27	0.01	1.688
FF–BALSAM POPLAR (4961)	11	0	0.688
FF–HORSETAIL Sw–Pb (4971)	12	0	0.75
TOTAL	351,932	100	21,995.75

South Fescue

Class Name	Count	%	Hectares
No Class	188,239	0	11,764.938
CREEPING MAHONIA WHITE MEADOWSWEET Fd (941)	6	0	0.375
THIMBLEBERRY PINE GRASS Aw (952)	7	0	0.438
WILLOW GROVELAND (1402)	2896	1.04	181
WET SEDGE MEADOW (1403)	99	0.04	6.188
ROUGH FESCUE Foothills (1433)	262,397	94.22	16,399.812
FF–LIMBER PINE/JUNIPER Fd–Pf (4911)	198	0.07	12.375

FF—BEARBERRY ASPEN (4922)	2391	0.86	149.438
FF—BEARBERRY Aw—Sw—Pl (4923)	53	0.02	3.312
FF—BUFFALOBERRY HAIRY WILD RYE—Fd (4931)	47	0.02	2.938
FF—CREEPING MAHONIA WHITE MEADOWSWEET Fd (4941)	1913	0.69	119.562
FF—CREEPING MAHONIA WHITE MEADOWSWEET Sw (4943)	1017	0.37	63.562
FF—THIMBLEBERRY PINE GRASS Aw (4952)	2479	0.89	154.938
FF—BALSAM POPLAR (4961)	2959	1.06	184.938
FF—HORSETAIL Sw—Pb (4971)	1981	0.71	123.812
FF—HORSETAIL Sw (4972)	37	0.01	2.312
TOTAL	278,480	100	17,405

Porcupine Hills

Class Name	Count	%	Hectares
No Class	67,354	0	4209.625
LIMBER PINE/JUNIPER Fd—Pf (911)	46,912	3.79	2932
LIMBER PINE/JUNIPER Hc (912)	316	0.03	19.75
BEARBERRY LODGEPOLE PINE (921)	33,497	2.71	2093.562
BEARBERRY ASPEN (922)	59,306	4.79	3706.625
BEARBERRY Aw—Sw—Pl (923)	20,306	1.64	1269.125
BEARBERRY Hc (924)	388	0.03	24.25
BUFFALOBERRY HAIRY WILD RYE Fd (931)	42,653	3.45	2665.812
BUFFALOBERRY HAIRY WILD RYE Hc (932)	160	0.01	10
CREEPING MAHONIA WHITE MEADOWSWEET Fd (941)	238,868	19.3	14,929.25
CREEPING MAHONIA WHITE MEADOWSWEET Pl (942)	100,989	8.16	6311.812
CREEPING MAHONIA WHITE MEADOWSWEET Sw (943)	30,102	2.43	1881.375
CREEPING MAHONIA WHITE MEADOWSWEET Hc (944)	3531	0.29	220.688
THIMBLEBERRY PINE GRASS Aw (952)	154,098	12.45	9631.125
THIMBLEBERRY PINE GRASS Hc (953)	297	0.02	18.562
BALSAM POPLAR (961)	22,159	1.79	1384.938
HORSETAIL Sw—Pb (971)	3333	0.27	208.312
HORSETAIL Sw (972)	1673	0.14	104.562
TM—FALSE AZALEA/THIMBLEBERRY Fa (2854)	1038	0.08	64.875
ROUGH FESCUE Parkland (1400)	55	0	3.438
WILLOW GROVELAND (1402)	155	0.01	9.688
DRY WILLOW Montane (1404)	29,421	2.38	1838.812
WET WILLOW (1406)	531	0.04	33.188
ROUGH FESCUE Foothills (1433)	1521	0.12	95.062
ROUGH FESCUE Montane (1934)	353,018	28.52	22,063.625
BLUE BUNCH WHEATGRASS (1935)	885	0.07	55.312
BEARBERRY GRASSLAND (1936)	91,932	7.43	5745.75
PINEGRASS HAIRY WILD RYE (1937)	26	0	1.625
PK—BEARBERRY ASPEN (3922)	39	0	2.438
PK—CREEPING MAHONIA WHITE MEADOWSWEET Sw (3943)	1	0	0.062
PK—THIMBLEBERRY PINE GRASS Aw (3952)	32	0	2
PK—BALSAM POPLAR (3961)	6	0	0.375
PK—HORSETAIL Sw—Pb (3971)	10	0	0.625
FF—LIMBER PINE/JUNIPER Fd—Pf (4911)	6	0	0.375
FF—BEARBERRY ASPEN (4922)	6	0	0.375
FF—CREEPING MAHONIA WHITE MEADOWSWEET Fd (4941)	5	0	0.312
FF—CREEPING MAHONIA WHITE MEADOWSWEET Sw (4943)	11	0	0.688
FF—THIMBLEBERRY PINE GRASS Aw (4952)	247	0.02	15.438
FF—BALSAM POPLAR (4961)	78	0.01	4.875
TOTAL	1,237,611	100	77,350.688

East Ranchlands

Class Name	Count	%	Hectares
No Class	87,338	0	5458.625
BEARBERRY LODGEPOLE PINE (921)	1	0	0.062
BEARBERRY ASPEN (922)	1	0	0.062
THIMBLEBERRY PINE GRASS Aw (952)	2	0	0.125
WILLOW GROVELAND (1402)	39,180	7.11	2448.75
WET SEDGE MEADOW (1403)	108	0.02	6.75
DRY WILLOW Montane (1404)	1	0	0.062
WET WILLOW (1406)	542	0.1	33.875
ROUGH FESCUE Foothills (1433)	489,958	88.91	30,622.375
BEARBERRY GRASSLAND (1936)	2	0	0.125
PK—THIMBLEBERRY PINE GRASS Aw (3952)	2	0	0.125
FF—LIMBER PINE/JUNIPER Fd—Pf (4911)	29	0.01	1.812
FF—BEARBERRY LODGEPOLE PINE (4921)	271	0.05	16.938
FF—BEARBERRY ASPEN (4922)	1102	0.2	68.875
FF—BEARBERRY Aw—Sw—Pl (4923)	507	0.09	31.688
FF—BUFFALOBERRY HAIRY WILD RYE—Fd (4931)	67	0.01	4.188
FF—CREEPING MAHONIA WHITE MEADOWSWEET Fd (4941)	2074	0.38	129.625
FF—CREEPING MAHONIA WHITE MEADOWSWEET Pl (4942)	974	0.18	60.875
FF—CREEPING MAHONIA WHITE MEADOWSWEET Sw (4943)	1133	0.21	70.812
FF—THIMBLEBERRY PINE GRASS Aw (4952)	8634	1.57	539.625
FF—BALSAM POPLAR (4961)	6453	1.17	403.312
TOTAL	551,041	100	34,440.061

APPENDIX 6 Seral Stage by Landscape Management Unit

Alpine High Rock

Class Name	Count	%	Hectares
No Class	102,167	0	6385.438
Young Seral GE (1940)	1138	3.76	71.125
Maturing Seral LT (1940) GE (1860)	1598	5.28	99.875
Young Edaphic Climax GE (1940)	470	1.55	29.375
Mature Edaphic Climax LT (1940)	5343	17.66	333.938
Young Climactic Climax GE (1940)	732	2.42	45.75
Mature Climactic Climax LT (1940)	20,982	69.33	1311.375
Total	30,263	100	1891.438

Head Water Valleys

Class Name	Count	%	Hectares
No Class	77,242	0	4827.625
Pioneer Seral GE (1990)	170	0.04	10.625
Young Seral GE (1940)	15,635	3.31	977.188
Maturing Seral LT (1940) GE (1860)	92,378	19.55	5773.625
Old Seral LT (1860)	6667	1.41	416.688
Young Edaphic Climax GE (1940)	7814	1.65	488.375
Mature Edaphic Climax LT (1940)	67,724	14.33	4232.75
Young Climactic Climax GE (1940)	39,773	8.42	2485.812
Mature Climactic Climax LT (1940)	242,311	51.29	15,144.438
Total	472,472	100	29,529.5

Flathead

Class Name	Count	%	Hectares
No Class	51,817	0	3238.562
Young Seral GE (1940)	14	0.04	0.875
Maturing Seral LT (1940) GE (1860)	11,906	35.23	744.125
Mature Edaphic Climax LT (1940)	6935	20.52	433.438
Mature Climactic Climax LT (1940)	14,944	44.21	934
Total	33,799	100	2112.438

Crowsnest Pass

Class Name	Count	%	Hectares
No Class	49,585	0	3099.062
Young Seral GE (1940)	462	0.64	28.875
Maturing Seral LT (1940) GE (1860)	20,628	28.47	1289.25
Old Seral LT (1860)	307	0.42	19.188
Young Edaphic Climax GE (1940)	2998	4.14	187.375
Mature Edaphic Climax LT (1940)	33,171	45.78	2073.188
Young Climactic Climax GE (1940)	64	0.09	4
Mature Climactic Climax LT (1940)	14,825	20.46	926.562
Total	72,455	100	4528.438

Middle Ridges

Class Name	Count	%	Hectares
No Class	192,987	0	12,061.688
Young Seral GE (1940)	892	0.09	55.75
Maturing Seral LT (1940) GE (1860)	417,190	42.4	26,074.375
Old Seral LT (1860)	17,594	1.79	1099.625
Young Edaphic Climax GE (1940)	1240	0.13	77.5
Mature Edaphic Climax LT (1940)	280,683	28.53	17,542.688
Young Climactic Climax GE (1940)	10,851	1.1	678.188
Mature Climactic Climax LT (1940)	255,521	25.97	15,970.062
Total	983,971	100	61,498.188

Ironstone

Class Name	Count	%	Hectares
No Class	10,926	0	682.875
Young Seral GE (1940)	919	0.72	57.438
Maturing Seral LT (1940) GE (1860)	82,294	64.89	5143.375
Old Seral LT (1860)	1490	1.17	93.125
Young Edaphic Climax GE (1940)	690	0.54	43.125
Mature Edaphic Climax LT (1940)	12,943	10.21	808.938
Young Climactic Climax GE (1940)	642	0.51	40.125
Mature Climactic Climax LT (1940)	27,844	21.96	1740.25
Total	126,822	100	7926.375

Hillcrest

Class Name	Count	%	Hectares
No Class	11,447	0	715.438
Young Seral GE (1940)	1823	2.83	113.938
Maturing Seral LT (1940) GE (1860)	38,504	59.8	2406.5
Young Edaphic Climax GE (1940)	993	1.54	62.062
Mature Edaphic Climax LT (1940)	11,701	18.17	731.312
Young Climactic Climax GE (1940)	1695	2.63	105.938
Mature Climactic Climax LT (1940)	9676	15.03	604.75
Total	64,392	100	4024.5

North Livingstone

Class Name	Count	%	Hectares
No Class	189,929	0	11,870.562
Young Seral GE (1940)	8359	2	522.438
Maturing Seral LT (1940) GE (1860)	163,815	39.24	10,238.438
Old Seral LT (1860)	15,305	3.67	956.562
Young Edaphic Climax GE (1940)	4191	1	261.938
Mature Edaphic Climax LT (1940)	114,238	27.37	7139.875
Young Climactic Climax GE (1940)	3594	0.86	224.625
Mature Climactic Climax LT (1940)	107,921	25.85	6745.062
Total	417,423	100	26,088.938

Livingstone Valley

Class Name	Count	%	Hectares
No Class	25,437	0	1589.812
Young Seral GE (1940)	189	0.21	11.812
Maturing Seral LT (1940) GE (1860)	31,745	35.34	1984.062
Old Seral LT (1860)	1305	1.45	81.562
Young Edaphic Climax GE (1940)	300	0.33	18.75
Mature Edaphic Climax LT (1940)	42,117	46.88	2632.312
Young Climactic Climax GE (1940)	726	0.81	45.375
Mature Climactic Climax LT (1940)	13,454	14.98	840.875
Total	89,836	100	5614.75

South Livingstone

Class Name	Count	%	Hectares
No Class	58,089	0	3630.562
Young Seral GE (1940)	707	1.04	44.188
Maturing Seral LT (1940) GE (1860)	42,240	62.01	2640
Old Seral LT (1860)	191	0.28	11.938
Young Edaphic Climax GE (1940)	801	1.18	50.062
Mature Edaphic Climax LT (1940)	17,932	26.33	1120.75
Mature Climactic Climax LT (1940)	6242	9.16	390.125
Total	68,113	100	4257.062

Beaver

Class Name	Count	%	Hectares
No Class	29,131	0	1820.688
Young Seral GE (1940)	3583	4.05	223.938
Maturing Seral LT (1940) GE (1860)	50,863	57.43	3178.938
Old Seral LT (1860)	1024	1.16	64
Young Edaphic Climax GE (1940)	2824	3.19	176.5
Mature Edaphic Climax LT (1940)	20,733	23.41	1295.812
Mature Climactic Climax LT (1940)	9539	10.77	596.188
Total	88,566	100	5535.375

Horseshoe Parkland

Class Name	Count	%	Hectares
No Class	761,891	0	47,618.188
Young Seral GE (1940)	90,406	29.1	5650.375
Maturing Seral LT (1940) GE (1860)	81,887	26.36	5117.938
Old Seral LT (1860)	215	0.07	13.438
Young Edaphic Climax GE (1940)	53,920	17.36	3370
Mature Edaphic Climax LT (1940)	54,698	17.61	3418.625
Young Climactic Climax GE (1940)	211	0.07	13.188
Mature Climactic Climax LT (1940)	29,351	9.45	1834.438
Total	310,688	100	19,418

Saddle Mountain

Class Name	Count	%	Hectares
No Class	48,401	0	3025.062
Young Seral GE (1940)	19,281	7.26	1205.062
Maturing Seral LT (1940) GE (1860)	117,632	44.27	7352
Old Seral LT (1860)	109	0.04	6.812
Young Edaphic Climax GE (1940)	18,689	7.03	1168.062
Mature Edaphic Climax LT (1940)	76,119	28.64	4757.438
Mature Climactic Climax LT (1940)	33,903	12.76	2118.938
Total	265,733	100	16,608.312

Whaleback

Class Name	Count	%	Hectares
No Class	247,254	0	15,453.375
Young Seral GE (1940)	15,664	4.07	979
Maturing Seral LT (1940) GE (1860)	237,224	61.6	14,826.5
Old Seral LT (1860)	3333	0.87	208.312
Young Edaphic Climax GE (1940)	10,167	2.64	635.438
Mature Edaphic Climax LT (1940)	89,448	23.23	5590.5
Young Climactic Climax GE (1940)	835	0.22	52.188
Mature Climactic Climax LT (1940)	28,462	7.39	1778.875
Total	385,133	100	24,070.812

Chapel Rock

Class Name	Count	%	Hectares
No Class	328,898	0	20,556.125
Pioneer Seral GE (1990)	85	0.1	5.312
Young Seral GE (1940)	13,207	14.93	825.438
Maturing Seral LT (1940) GE (1860)	41,090	46.45	2568.125
Young Edaphic Climax GE (1940)	3639	4.11	227.438
Mature Edaphic Climax LT (1940)	25,720	29.08	1607.5
Mature Climactic Climax LT (1940)	4713	5.33	294.562
Total	88,454	100	5528.375

South Fescue

Class Name	Count	%	Hectares
No Class	453,579	0	28,348.688
Young Seral GE (1940)	291	2.21	18.188
Maturing Seral LT (1940) GE (1860)	4144	31.54	259
Young Edaphic Climax GE (1940)	251	1.91	15.688
Mature Edaphic Climax LT (1940)	7437	56.6	464.812
Mature Climactic Climax LT (1940)	1017	7.74	63.562
Total	13,140	100	821.25

Porcupine Hills

Class Name	Count	%	Hectares
No Class	552,297	0	34,518.562
Young Seral GE (1940)	111,948	14.87	6996.75
Maturing Seral LT (1940) GE (1860)	397,193	52.77	24,824.562
Old Seral LT (1860)	25,243	3.35	1577.688
Young Edaphic Climax GE (1940)	60,138	7.99	3758.625
Mature Edaphic Climax LT (1940)	127,048	16.88	7940.5
Young Climactic Climax GE (1940)	603	0.08	37.688
Mature Climactic Climax LT (1940)	30,495	4.05	1905.938
Total	752,668	100	47,041.75

East Ranchlands

Class Name	Count	%	Hectares
No Class	617,090	0	38,568.125
Young Seral GE (1940)	7874	36.99	492.125
Maturing Seral LT (1940) GE (1860)	3869	18.17	241.812
Young Edaphic Climax GE (1940)	4318	20.28	269.875
Mature Edaphic Climax LT (1940)	4095	19.24	255.938
Mature Climactic Climax LT (1940)	1133	5.32	70.812
Total	21,289	100	1330.562

APPENDIX 7 Ecosite Phase by Maturity Class by LMU

Alpine High Rock

Class Name	Count	%	Hectares
No Class	102,167	0	6385.438
1940 to today : LICHEN LODGEPOLE PINE (811)	338	1.12	21.125
1940 to today : BEARBERRY/HAIRY WILD RYE LODGEPOLE PINE (821)	12	0.04	0.75
1940 to today : SUBALPINE LARCH/HEATHER La—Fa (831)	77	0.25	4.812
1940 to today : SPRUCE/HEATHER Se NORTH (841)	619	2.05	38.688
1940 to today : FALSE AZALEA/THIMBLEBERRY Pl (851)	937	3.1	58.562
1940 to today : FALSE AZALEA/GROUSEBERRY WHITEBARK PINE (852)	201	0.66	12.562
1940 to today : FALSE AZALEA/THIMBLEBERRY Se NORTH (853)	68	0.22	4.25
1940 to today : FALSE AZALEA/THIMBLEBERRY Fa (854)	45	0.15	2.812
1940 to today : TS—LIMBER PINE/JUNIPER Fd—Pf (2911)	43	0.14	2.688
1870 to 1930 : LICHEN LODGEPOLE PINE (811)	186	0.61	11.625
1870 to 1930 : BEARBERRY/HAIRY WILD RYE LODGEPOLE PINE (821)	128	0.42	8
1870 to 1930 : SUBALPINE LARCH/HEATHER La—Fa (831)	3911	12.92	244.438
1870 to 1930 : SPRUCE/HEATHER Se NORTH (841)	9526	31.48	595.375
1870 to 1930 : FALSE AZALEA/THIMBLEBERRY Pl (851)	1439	4.75	89.938
1870 to 1930 : FALSE AZALEA/GROUSEBERRY WHITEBARK PINE (852)	66	0.22	4.125
1870 to 1930 : FALSE AZALEA/THIMBLEBERRY Fa (854)	4472	14.78	279.5
1870 to 1930 : TS—LIMBER PINE/JUNIPER Fd—Pf (2911)	130	0.43	8.125
1870 to 1930 : TS—BEARBERRY Aw—Sw—Pl (2923)	151	0.5	9.438
1870 to 1930 : TS—THIMBLEBERRY PINE GRASS Aw (2952)	93	0.31	5.812
1860 and before : SUBALPINE LARCH/HEATHER La—Fa (831)	837	2.77	52.312
1860 and before : SPRUCE/HEATHER Se NORTH (841)	6677	22.06	417.312
1860 and before : FALSE AZALEA/THIMBLEBERRY Se NORTH (853)	267	0.88	16.688
1860 and before : FALSE AZALEA/THIMBLEBERRY Fa (854)	40	0.13	2.5
Total	30,263	100	1891.438

Head Water Valleys

Class Name	Count	%	Hectares
No Class	77,242	0	4827.625
1940 to today : LICHEN LODGEPOLE PINE (811)	3673	0.78	229.562
1940 to today : BEARBERRY/HAIRY WILD RYE LODGEPOLE PINE (821)	3394	0.72	212.125
1940 to today : SUBALPINE LARCH/HEATHER La—Fa (831)	595	0.13	37.188
1940 to today : SPRUCE/HEATHER Se NORTH (841)	7516	1.59	469.75
1940 to today : FALSE AZALEA/THIMBLEBERRY Pl (851)	15,595	3.3	974.688
1940 to today : FALSE AZALEA/GROUSEBERRY WHITEBARK PINE (852)	40	0.01	2.5
1940 to today : FALSE AZALEA/THIMBLEBERRY Se NORTH (853)	29,657	6.28	1853.562
1940 to today : FALSE AZALEA/THIMBLEBERRY Fa (854)	1577	0.33	98.562
1940 to today : HORSETAIL Se (881)	29	0.01	1.812
1940 to today : TS—LIMBER PINE/JUNIPER Fd—Pf (2911)	17	0	1.062
1940 to today : TS—BEARBERRY ASPEN (2922)	20	0	1.25
1940 to today : TS—BEARBERRY Aw—Sw—Pl (2923)	86	0.02	5.375
1940 to today : TS—CREEPING MAHONIA WHITE MEADOWSWEET Sw (2943)	1193	0.25	74.562
1870 to 1930 : LICHEN LODGEPOLE PINE (811)	4515	0.96	282.188
1870 to 1930 : BEARBERRY/HAIRY WILD RYE LODGEPOLE PINE (821)	31,067	6.58	1941.688
1870 to 1930 : SUBALPINE LARCH/HEATHER La—Fa (831)	7661	1.62	478.812
1870 to 1930 : SPRUCE/HEATHER Se NORTH (841)	51,498	10.9	3218.625
1870 to 1930 : FALSE AZALEA/THIMBLEBERRY Pl (851)	88,012	18.63	5500.75
1870 to 1930 : FALSE AZALEA/GROUSEBERRY WHITEBARK PINE (852)	52	0.01	3.25
1870 to 1930 : FALSE AZALEA/THIMBLEBERRY Se NORTH (853)	25,774	5.46	1610.875
1870 to 1930 : FALSE AZALEA/THIMBLEBERRY Fa (854)	4459	0.94	278.688
1870 to 1930 : HORSETAIL Se (881)	1429	0.3	89.312
1870 to 1930 : TS—LIMBER PINE/JUNIPER Fd—Pf (2911)	66	0.01	4.125
1870 to 1930 : TS—BEARBERRY ASPEN (2922)	132	0.03	8.25
1870 to 1930 : TS—BEARBERRY Aw—Sw—Pl (2923)	1101	0.23	68.812
1870 to 1930 : TS—BUFFALOBERRY HAIRY WILD RYE Fd (2931)	8	0	0.5

1870 to 1930 : TS—CREEPING MAHONIA WHITE MEADOWSWEET Fd (2941)	10	0	0.625
1870 to 1930 : TS—CREEPING MAHONIA WHITE MEADOWSWEET Sw (2943)	385	0.08	24.062
1870 to 1930 : TS—THIMBLEBERRY PINE GRASS Aw (2952)	445	0.09	27.812
1870 to 1930 : TS—HORSETAIL Sw—Pb (2971)	324	0.07	20.25
1870 to 1930 : BEARBERRY LODGEPOLE PINE (921)	13	0	0.812
1870 to 1930 : CREEPING MAHONIA WHITE MEADOWSWEET Pl (942)	14	0	0.875
1860 and before : LICHEN LODGEPOLE PINE (811)	611	0.13	38.188
1860 and before : BEARBERRY/HAIRY WILD RYE LODGEPOLE PINE (821)	6990	1.48	436.875
1860 and before : SUBALPINE LARCH/HEATHER La—Fa (831)	10,498	2.22	656.125
1860 and before : SPRUCE/HEATHER Se NORTH (841)	102,238	21.64	6389.875
1860 and before : FALSE AZALEA/THIMBLEBERRY Pl (851)	8995	1.9	562.188
1860 and before : FALSE AZALEA/GROUSEBERRY WHITEBARK PINE (852)	1509	0.32	94.312
1860 and before : FALSE AZALEA/THIMBLEBERRY Se NORTH (853)	56,095	11.87	3505.938
1860 and before : FALSE AZALEA/THIMBLEBERRY Fa (854)	1856	0.39	116
1860 and before : HORSETAIL Se (881)	3292	0.7	205.75
1860 and before : TS—LIMBER PINE/JUNIPER Fd—Pf (2911)	18	0	1.125
1860 and before : TS—BEARBERRY Aw—Sw—Pl (2923)	7	0	0.438
1860 and before : TS—CREEPING MAHONIA WHITE MEADOWSWEET Sw (2943)	6	0	0.375
Total	472,472	100	29,529.5

Flathead

Class Name	Count	%	Hectares
No Class	51,817	0	3238.562
1940 to today : THIMBLEBERRY PINE GRASS Aw (952)	14	0.04	0.875
1870 to 1930 : LICHEN LODGEPOLE PINE (811)	3003	8.88	187.688
1870 to 1930 : BEARBERRY/HAIRY WILD RYE LODGEPOLE PINE (821)	3653	10.81	228.312
1870 to 1930 : SUBALPINE LARCH/HEATHER La—Fa (831)	176	0.52	11
1870 to 1930 : SPRUCE/HEATHER Se NORTH (841)	5724	16.94	357.75
1870 to 1930 : FALSE AZALEA/THIMBLEBERRY Pl (851)	10,708	31.68	669.25
1870 to 1930 : FALSE AZALEA/THIMBLEBERRY Se NORTH (853)	2055	6.08	128.438
1870 to 1930 : FALSE AZALEA/THIMBLEBERRY Fa (854)	5108	15.11	319.25
1870 to 1930 : TS—BEARBERRY Aw—Sw—Pl (2923)	74	0.22	4.625
1870 to 1930 : TS—CREEPING MAHONIA WHITE MEADOWSWEET Sw (2943)	152	0.45	9.5
1870 to 1930 : TS—THIMBLEBERRY PINE GRASS Aw (2952)	27	0.08	1.688
1870 to 1930 : BEARBERRY LODGEPOLE PINE (921)	18	0.05	1.125
1870 to 1930 : CREEPING MAHONIA WHITE MEADOWSWEET Pl (942)	1171	3.46	73.188
1860 and before : SUBALPINE LARCH/HEATHER La—Fa (831)	11	0.03	0.688
1860 and before : SPRUCE/HEATHER Se NORTH (841)	1446	4.28	90.375
1860 and before : FALSE AZALEA/THIMBLEBERRY Se NORTH (853)	162	0.48	10.125
1860 and before : FALSE AZALEA/THIMBLEBERRY Fa (854)	297	0.88	18.562
Total	33,799	100	2112.438

Crowsnest Pass

Class Name	Count	%	Hectares
No Class	49,586	0	3099.125
1940 to today : LICHEN LODGEPOLE PINE (811)	104	0.14	6.5
1940 to today : FALSE AZALEA/THIMBLEBERRY Pl (851)	58	0.08	3.625
1940 to today : TS—LIMBER PINE/JUNIPER Fd—Pf (2911)	4	0.01	0.25
1940 to today : TS—BEARBERRY ASPEN (2922)	23	0.03	1.438
1940 to today : TS—CREEPING MAHONIA WHITE MEADOWSWEET Fd (2941)	96	0.13	6
1940 to today : BEARBERRY LODGEPOLE PINE (921)	2468	3.41	154.25
1940 to today : BEARBERRY ASPEN (922)	383	0.53	23.938
1940 to today : BEARBERRY Aw—Sw—Pl (923)	5	0.01	0.312
1940 to today : CREEPING MAHONIA WHITE MEADOWSWEET Pl (942)	274	0.38	17.125
1940 to today : CREEPING MAHONIA WHITE MEADOWSWEET Sw (943)	1	0	0.062

1940 to today : THIMBLEBERRY PINE GRASS Aw (952)	34	0.05	2.125
1940 to today : HORSETAIL Sw (972)	11	0.02	0.688
1940 to today : TM—FALSE AZALEA/THIMBLEBERRY Fa (2854)	63	0.09	3.938
1870 to 1930 : LICHEN LODGEPOLE PINE (811)	49	0.07	3.062
1870 to 1930 : BEARBERRY/HAIRY WILD RYE LODGEPOLE PINE (821)	385	0.53	24.062
1870 to 1930 : FALSE AZALEA/THIMBLEBERRY Pl (851)	2805	3.87	175.312
1870 to 1930 : FALSE AZALEA/THIMBLEBERRY Se NORTH (853)	443	0.61	27.688
1870 to 1930 : FALSE AZALEA/THIMBLEBERRY Fa (854)	2	0	0.125
1870 to 1930 : TS—BEARBERRY ASPEN (2922)	129	0.18	8.062
1870 to 1930 : TS—BEARBERRY Aw—Sw—Pl (2923)	2606	3.6	162.875
1870 to 1930 : TS—CREEPING MAHONIA WHITE MEADOWSWEET Fd (2941)	7	0.01	0.438
1870 to 1930 : TS—CREEPING MAHONIA WHITE MEADOWSWEET Sw (2943)	125	0.17	7.812
1870 to 1930 : TS—THIMBLEBERRY PINE GRASS Aw (2952)	167	0.23	10.438
1870 to 1930 : LIMBER PINE/JUNIPER Fd—Pf (911)	1041	1.44	65.062
1870 to 1930 : BEARBERRY LODGEPOLE PINE (921)	20,223	27.91	1263.938
1870 to 1930 : BEARBERRY ASPEN (922)	3858	5.32	241.125
1870 to 1930 : BEARBERRY Aw—Sw—Pl (923)	3654	5.04	228.375
1870 to 1930 : BUFFALOBERRY HAIRY WILD RYE Fd (931)	2463	3.4	153.938
1870 to 1930 : CREEPING MAHONIA WHITE MEADOWSWEET Fd (941)	2938	4.05	183.625
1870 to 1930 : CREEPING MAHONIA WHITE MEADOWSWEET Pl (942)	10,756	14.85	672.25
1870 to 1930 : CREEPING MAHONIA WHITE MEADOWSWEET Sw (943)	10,550	14.56	659.375
1870 to 1930 : THIMBLEBERRY PINE GRASS Aw (952)	1492	2.06	93.25
1870 to 1930 : HORSETAIL Sw (972)	908	1.25	56.75
1870 to 1930 : TM—FALSE AZALEA/THIMBLEBERRY Fa (2854)	2614	3.61	163.375
1860 and before : LIMBER PINE/JUNIPER Fd—Pf (911)	158	0.22	9.875
1860 and before : BEARBERRY Aw—Sw—Pl (923)	159	0.22	9.938
1860 and before : CREEPING MAHONIA WHITE MEADOWSWEET Fd (941)	307	0.42	19.188
1860 and before : CREEPING MAHONIA WHITE MEADOWSWEET Sw (943)	1091	1.51	68.188
Total	72,454	100	4528.375

Middle Ridges

Class Name	Count	%	Hectares
No Class	192,988	0	12,061.75
1940 to today : LICHEN LODGEPOLE PINE (811)	431	0.04	26.938
1940 to today : BEARBERRY/HAIRY WILD RYE LODGEPOLE PINE (821)	66	0.01	4.125
1940 to today : SUBALPINE LARCH/HEATHER La—Fa (831)	78	0.01	4.875
1940 to today : SPRUCE/HEATHER Se NORTH (841)	3347	0.34	209.188
1940 to today : FALSE AZALEA/THIMBLEBERRY Pl (851)	392	0.04	24.5
1940 to today : FALSE AZALEA/GROUSEBERRY WHITEBARK PINE (852)	38	0	2.375
1940 to today : FALSE AZALEA/THIMBLEBERRY Se NORTH (853)	7349	0.75	459.312
1940 to today : FALSE AZALEA/THIMBLEBERRY Fa (854)	155	0.02	9.688
1940 to today : HORSETAIL Se (881)	11	0	0.688
1940 to today : TS—LIMBER PINE/JUNIPER Fd—Pf (2911)	359	0.04	22.438
1940 to today : TS—BEARBERRY ASPEN (2922)	236	0.02	14.75
1940 to today : TS—BEARBERRY Aw—Sw—Pl (2923)	59	0.01	3.688
1940 to today : TS—BUFFALOBERRY HAIRY WILD RYE Fd (2931)	131	0.01	8.188
1940 to today : TS—CREEPING MAHONIA WHITE MEADOWSWEET Fd (2941)	217	0.02	13.562
1940 to today : TS—THIMBLEBERRY PINE GRASS Aw (2952)	114	0.01	7.125
1870 to 1930 : LICHEN LODGEPOLE PINE (811)	34,837	3.54	2177.312
1870 to 1930 : BEARBERRY/HAIRY WILD RYE LODGEPOLE PINE (821)	163,109	16.58	10,194.31
1870 to 1930 : SUBALPINE LARCH/HEATHER La—Fa (831)	7964	0.81	497.75
1870 to 1930 : SPRUCE/HEATHER Se NORTH (841)	69,465	7.06	4341.562
1870 to 1930 : FALSE AZALEA/THIMBLEBERRY Pl (851)	383,640	38.99	23,977.5
1870 to 1930 : FALSE AZALEA/GROUSEBERRY WHITEBARK PINE (852)	2284	0.23	142.75
1870 to 1930 : FALSE AZALEA/THIMBLEBERRY Se NORTH (853)	67,653	6.88	4228.312
1870 to 1930 : FALSE AZALEA/THIMBLEBERRY Fa (854)	4949	0.5	309.312
1870 to 1930 : HORSETAIL Se (881)	2023	0.21	126.438
1870 to 1930 : TS—LIMBER PINE/JUNIPER Fd—Pf (2911)	3044	0.31	190.25
1870 to 1930 : TS—BEARBERRY ASPEN (2922)	7882	0.8	492.625

1870 to 1930 : TS—BEARBERRY Aw—Sw—Pl (2923)	26,269	2.67	1641.812
1870 to 1930 : TS—BUFFALOBERRY HAIRY WILD RYE Fd (2931)	5474	0.56	342.125
1870 to 1930 : TS—CREEPING MAHONIA WHITE MEADOWSWEET Fd (2941)	11,758	1.19	734.875
1870 to 1930 : TS—CREEPING MAHONIA WHITE MEADOWSWEET Sw (2943)	3745	0.38	234.062
1870 to 1930 : TS—THIMBLEBERRY PINE GRASS Aw (2952)	5144	0.52	321.5
1870 to 1930 : TS—BALSAM POPLAR (2961)	167	0.02	10.438
1870 to 1930 : TS—HORSETAIL Sw—Pb (2971)	463	0.05	28.938
1860 and before : LICHEN LODGEPOLE PINE (811)	1727	0.18	107.938
1860 and before : BEARBERRY/HAIRY WILD RYE LODGEPOLE PINE (821)	9795	1	612.188
1860 and before : SUBALPINE LARCH/HEATHER La—Fa (831)	15,795	1.61	987.188
1860 and before : SPRUCE/HEATHER Se NORTH (841)	81,776	8.31	5111
1860 and before : FALSE AZALEA/THIMBLEBERRY Pl (851)	23,738	2.41	1483.625
1860 and before : FALSE AZALEA/GROUSEBERRY WHITEBARK PINE (852)	1291	0.13	80.688
1860 and before : FALSE AZALEA/THIMBLEBERRY Se NORTH (853)	27,443	2.79	1715.188
1860 and before : FALSE AZALEA/THIMBLEBERRY Fa (854)	490	0.05	30.625
1860 and before : HORSETAIL Se (881)	6073	0.62	379.562
1860 and before : TS—LIMBER PINE/JUNIPER Fd—Pf (2911)	962	0.1	60.125
1860 and before : TS—BEARBERRY Aw—Sw—Pl (2923)	537	0.05	33.562
1860 and before : TS—BUFFALOBERRY HAIRY WILD RYE Fd (2931)	385	0.04	24.062
1860 and before : TS—CREEPING MAHONIA WHITE MEADOWSWEET Fd (2941)	1069	0.11	66.812
1860 and before : TS—HORSETAIL Sw—Pb (2971)	36	0	2.25
Total	983,970	100	61,498.13

Ironstone

Class Name	Count	%	Hectares
No Class	10,926	0	682.875
1940 to today : LICHEN LODGEPOLE PINE (811)	497	0.39	31.062
1940 to today : BEARBERRY/HAIRY WILD RYE LODGEPOLE PINE (821)	22	0.02	1.375
1940 to today : FALSE AZALEA/THIMBLEBERRY Pl (851)	717	0.57	44.812
1940 to today : FALSE AZALEA/THIMBLEBERRY Se NORTH (853)	497	0.39	31.062
1940 to today : FALSE AZALEA/THIMBLEBERRY Fa (854)	140	0.11	8.75
1940 to today : HORSETAIL Se (881)	2	0	0.125
1940 to today : TS—BEARBERRY ASPEN (2922)	148	0.12	9.25
1940 to today : TS—BEARBERRY Aw—Sw—Pl (2923)	1	0	0.062
1940 to today : TS—THIMBLEBERRY PINE GRASS Aw (2952)	202	0.16	12.625
1940 to today : BEARBERRY ASPEN (922)	17	0.01	1.062
1940 to today : CREEPING MAHONIA WHITE MEADOWSWEET Sw (943)	5	0	0.312
1940 to today : HORSETAIL Sw (972)	3	0	0.188
1870 to 1930 : LICHEN LODGEPOLE PINE (811)	2010	1.58	125.625
1870 to 1930 : BEARBERRY/HAIRY WILD RYE LODGEPOLE PINE (821)	7386	5.82	461.625
1870 to 1930 : SUBALPINE LARCH/HEATHER La—Fa (831)	31	0.02	1.938
1870 to 1930 : SPRUCE/HEATHER Se NORTH (841)	1367	1.08	85.438
1870 to 1930 : FALSE AZALEA/THIMBLEBERRY Pl (851)	72,921	57.5	4557.562
1870 to 1930 : FALSE AZALEA/THIMBLEBERRY Se NORTH (853)	17,903	14.12	1118.938
1870 to 1930 : FALSE AZALEA/THIMBLEBERRY Fa (854)	5165	4.07	322.812
1870 to 1930 : HORSETAIL Se (881)	319	0.25	19.938
1870 to 1930 : TS—BEARBERRY ASPEN (2922)	539	0.43	33.688
1870 to 1930 : TS—BEARBERRY Aw—Sw—Pl (2923)	597	0.47	37.312
1870 to 1930 : TS—CREEPING MAHONIA WHITE MEADOWSWEET Sw (2943)	181	0.14	11.312
1870 to 1930 : TS—THIMBLEBERRY PINE GRASS Aw (2952)	4346	3.43	271.625
1870 to 1930 : BEARBERRY LODGEPOLE PINE (921)	1227	0.97	76.688
1870 to 1930 : BEARBERRY ASPEN (922)	45	0.04	2.812
1870 to 1930 : BEARBERRY Aw—Sw—Pl (923)	239	0.19	14.938
1870 to 1930 : CREEPING MAHONIA WHITE MEADOWSWEET Pl (942)	4959	3.91	309.938
1870 to 1930 : CREEPING MAHONIA WHITE MEADOWSWEET Sw (943)	578	0.46	36.125
1870 to 1930 : THIMBLEBERRY PINE GRASS Aw (952)	68	0.05	4.25
1870 to 1930 : HORSETAIL Sw (972)	136	0.11	8.5
1860 and before : BEARBERRY/HAIRY WILD RYE LODGEPOLE PINE (821)	414	0.33	25.875
1860 and before : SPRUCE/HEATHER Se NORTH (841)	961	0.76	60.062

1860 and before : FALSE AZALEA/THIMBLEBERRY Pl (851)	1490	1.17	93.125
1860 and before : FALSE AZALEA/THIMBLEBERRY Se NORTH (853)	1572	1.24	98.25
1860 and before : FALSE AZALEA/THIMBLEBERRY Fa (854)	117	0.09	7.312
Total	126,822	100	7926.375

Hillcrest

Class Name	Count	%	Hectares
No Class	11,447	0	715.438
1940 to today : BEARBERRY/HAIRY WILD RYE LODGEPOLE PINE (821)	6	0.01	0.375
1940 to today : SPRUCE/HEATHER Se NORTH (841)	60	0.09	3.75
1940 to today : FALSE AZALEA/THIMBLEBERRY Pl (851)	284	0.44	17.75
1940 to today : FALSE AZALEA/THIMBLEBERRY Se NORTH (853)	336	0.52	21
1940 to today : FALSE AZALEA/THIMBLEBERRY Fa (854)	1299	2.02	81.188
1940 to today : TS—BEARBERRY ASPEN (2922)	466	0.72	29.125
1940 to today : TS—BEARBERRY Aw—Sw—Pl (2923)	511	0.79	31.938
1940 to today : TS—THIMBLEBERRY PINE GRASS Aw (2952)	1507	2.34	94.188
1940 to today : BEARBERRY LODGEPOLE PINE (921)	9	0.01	0.562
1940 to today : BEARBERRY Aw—Sw—Pl (923)	1	0	0.062
1940 to today : CREEPING MAHONIA WHITE MEADOWSWEET Pl (942)	20	0.03	1.25
1940 to today : THIMBLEBERRY PINE GRASS Aw (952)	12	0.02	0.75
1870 to 1930 : LICHEN LODGEPOLE PINE (811)	1998	3.1	124.875
1870 to 1930 : BEARBERRY/HAIRY WILD RYE LODGEPOLE PINE (821)	9037	14.03	564.812
1870 to 1930 : SPRUCE/HEATHER Se NORTH (841)	1643	2.55	102.688
1870 to 1930 : FALSE AZALEA/THIMBLEBERRY Pl (851)	34,032	52.85	2127
1870 to 1930 : FALSE AZALEA/THIMBLEBERRY Se NORTH (853)	4371	6.79	273.188
1870 to 1930 : FALSE AZALEA/THIMBLEBERRY Fa (854)	3146	4.89	196.625
1870 to 1930 : TS—LIMBER PINE/JUNIPER Fd—Pf (2911)	436	0.68	27.25
1870 to 1930 : TS—BEARBERRY ASPEN (2922)	44	0.07	2.75
1870 to 1930 : TS—BEARBERRY Aw—Sw—Pl (2923)	28	0.04	1.75
1870 to 1930 : TS—BUFFALOBERRY HAIRY WILD RYE Fd (2931)	283	0.44	17.688
1870 to 1930 : TS—CREEPING MAHONIA WHITE MEADOWSWEET Fd (2941)	3427	5.32	214.188
1870 to 1930 : TS—CREEPING MAHONIA WHITE MEADOWSWEET Sw (2943)	15	0.02	0.938
1870 to 1930 : TS—THIMBLEBERRY PINE GRASS Aw (2952)	459	0.71	28.688
1870 to 1930 : BEARBERRY LODGEPOLE PINE (921)	151	0.23	9.438
1870 to 1930 : BEARBERRY Aw—Sw—Pl (923)	7	0.01	0.438
1870 to 1930 : BUFFALOBERRY HAIRY WILD RYE Fd (931)	8	0.01	0.5
1870 to 1930 : CREEPING MAHONIA WHITE MEADOWSWEET Fd (941)	153	0.24	9.562
1870 to 1930 : CREEPING MAHONIA WHITE MEADOWSWEET Pl (942)	138	0.21	8.625
1870 to 1930 : CREEPING MAHONIA WHITE MEADOWSWEET Sw (943)	77	0.12	4.812
1870 to 1930 : THIMBLEBERRY PINE GRASS Aw (952)	4	0.01	0.25
1870 to 1930 : TM—FALSE AZALEA/THIMBLEBERRY Fa (2854)	4	0.01	0.25
1860 and before : FALSE AZALEA/THIMBLEBERRY Se NORTH (853)	420	0.65	26.25
Total	64,392	100	4024.5

North Livingstone

Class Name	Count	%	Hectares
No Class	189,929	0	11,870.56
1940 to today : LICHEN LODGEPOLE PINE (811)	1315	0.32	82.188
1940 to today : BEARBERRY/HAIRY WILD RYE LODGEPOLE PINE (821)	100	0.02	6.25
1940 to today : SPRUCE/HEATHER Se NORTH (841)	219	0.05	13.688
1940 to today : FALSE AZALEA/THIMBLEBERRY Pl (851)	687	0.16	42.938
1940 to today : FALSE AZALEA/THIMBLEBERRY Se NORTH (853)	3201	0.77	200.062
1940 to today : TS—BEARBERRY ASPEN (2922)	1946	0.47	121.625
1940 to today : TS—BEARBERRY Aw—Sw—Pl (2923)	732	0.18	45.75
1940 to today : TS—CREEPING MAHONIA WHITE MEADOWSWEET Sw (2943)	174	0.04	10.875

1940 to today : TS—THIMBLEBERRY PINE GRASS Aw (2952)	7672	1.84	479.5
1940 to today : TS—BALSAM POPLAR (2961)	98	0.02	6.125
1870 to 1930 : LICHEN LODGEPOLE PINE (811)	16,642	3.99	1040.125
1870 to 1930 : BEARBERRY/HAIRY WILD RYE LODGEPOLE PINE (821)	58,498	14.01	3656.125
1870 to 1930 : SUBALPINE LARCH/HEATHER La—Fa (831)	3813	0.91	238.312
1870 to 1930 : SPRUCE/HEATHER Se NORTH (841)	28,509	6.83	1781.812
1870 to 1930 : FALSE AZALEA/THIMBLEBERRY Pl (851)	144,275	34.56	9017.188
1870 to 1930 : FALSE AZALEA/GROUSEBERRY WHITEBARK PINE (852)	1451	0.35	90.688
1870 to 1930 : FALSE AZALEA/THIMBLEBERRY Se NORTH (853)	27,650	6.62	1728.125
1870 to 1930 : FALSE AZALEA/THIMBLEBERRY Fa (854)	874	0.21	54.625
1870 to 1930 : HORSETAIL Se (881)	624	0.15	39
1870 to 1930 : TS—LIMBER PINE/JUNIPER Fd—Pf (2911)	780	0.19	48.75
1870 to 1930 : TS—BEARBERRY ASPEN (2922)	5803	1.39	362.688
1870 to 1930 : TS—BEARBERRY Aw—Sw—Pl (2923)	5517	1.32	344.812
1870 to 1930 : TS—BUFFALOBERRY HAIRY WILD RYE Fd (2931)	664	0.16	41.5
1870 to 1930 : TS—CREEPING MAHONIA WHITE MEADOWSWEET Fd (2941)	2343	0.56	146.438
1870 to 1930 : TS—CREEPING MAHONIA WHITE MEADOWSWEET Sw (2943)	4628	1.11	289.25
1870 to 1930 : TS—THIMBLEBERRY PINE GRASS Aw (2952)	11,531	2.76	720.688
1870 to 1930 : TS—BALSAM POPLAR (2961)	16,101	3.86	1006.312
1870 to 1930 : TS—HORSETAIL Sw—Pb (2971)	420	0.1	26.25
1870 to 1930 : BEARBERRY Aw—Sw—Pl (923)	1	0	0.062
1870 to 1930 : PK—CREEPING MAHONIA WHITE MEADOWSWEET Pl (3942)	2	0	0.125
1860 and before : LICHEN LODGEPOLE PINE (811)	510	0.12	31.875
1860 and before : BEARBERRY/HAIRY WILD RYE LODGEPOLE PINE (821)	4776	1.14	298.5
1860 and before : SUBALPINE LARCH/HEATHER La—Fa (831)	539	0.13	33.688
1860 and before : SPRUCE/HEATHER Se NORTH (841)	31,705	7.6	1981.562
1860 and before : FALSE AZALEA/THIMBLEBERRY Pl (851)	17,280	4.14	1080
1860 and before : FALSE AZALEA/GROUSEBERRY WHITEBARK PINE (852)	1574	0.38	98.375
1860 and before : FALSE AZALEA/THIMBLEBERRY Se NORTH (853)	14,501	3.47	906.312
1860 and before : FALSE AZALEA/THIMBLEBERRY Fa (854)	54	0.01	3.375
1860 and before : HORSETAIL Se (881)	214	0.05	13.375
Total	417,423	100	26,088.94

Livingstone Valley

Class Name	Count	%	Hectares
No Class	25,437	0	1589.812
1940 to today : BEARBERRY LODGEPOLE PINE (921)	263	0.29	16.438
1940 to today : CREEPING MAHONIA WHITE MEADOWSWEET Pl (942)	189	0.21	11.812
1940 to today : CREEPING MAHONIA WHITE MEADOWSWEET Sw (943)	726	0.81	45.375
1940 to today : HORSETAIL Sw (972)	37	0.04	2.312
1870 to 1930 : LIMBER PINE/JUNIPER Fd—Pf (911)	38	0.04	2.375
1870 to 1930 : BEARBERRY LODGEPOLE PINE (921)	26,593	29.6	1662.062
1870 to 1930 : BEARBERRY ASPEN (922)	2047	2.28	127.938
1870 to 1930 : BEARBERRY Aw—Sw—Pl (923)	5123	5.7	320.188
1870 to 1930 : BUFFALOBERRY HAIRY WILD RYE Fd (931)	49	0.05	3.062
1870 to 1930 : CREEPING MAHONIA WHITE MEADOWSWEET Fd (941)	45	0.05	2.812
1870 to 1930 : CREEPING MAHONIA WHITE MEADOWSWEET Pl (942)	30,164	33.58	1885.25
1870 to 1930 : CREEPING MAHONIA WHITE MEADOWSWEET Sw (943)	3151	3.51	196.938
1870 to 1930 : THIMBLEBERRY PINE GRASS Aw (952)	1487	1.66	92.938
1870 to 1930 : BALSAM POPLAR (961)	97	0.11	6.062
1870 to 1930 : HORSETAIL Sw—Pb (971)	3088	3.44	193
1870 to 1930 : HORSETAIL Sw (972)	1103	1.23	68.938
1870 to 1930 : TM—SUBALPINE LARCH/HEATHER La—Fa (2831)	3	0	0.188
1870 to 1930 : TM—FALSE AZALEA/THIMBLEBERRY Fa (2854)	34	0.04	2.125
1860 and before : BEARBERRY LODGEPOLE PINE (921)	1513	1.68	94.562
1860 and before : BEARBERRY Aw—Sw—Pl (923)	165	0.18	10.312
1860 and before : CREEPING MAHONIA WHITE MEADOWSWEET Pl (942)	1305	1.45	81.562
1860 and before : CREEPING MAHONIA WHITE MEADOWSWEET Sw (943)	10,237	11.4	639.812
1860 and before : HORSETAIL Sw—Pb (971)	64	0.07	4

1860 and before : HORSETAIL Sw (972)	2283	2.54	142.688
1860 and before : TM–FALSE AZALEA/THIMBLEBERRY Fa (2854)	32	0.04	2
Total	89,836	100	5614.75

South Livingstone

Class Name	Count	%	Hectares
No Class	58,089	0	3630.562
1940 to today : BEARBERRY/HAIRY WILD RYE LODGEPOLE PINE (821)	4	0.01	0.25
1940 to today : FALSE AZALEA/THIMBLEBERRY Pl (851)	104	0.15	6.5
1940 to today : TS–LIMBER PINE/JUNIPER Fd–Pf (2911)	468	0.69	29.25
1940 to today : TS–BEARBERRY ASPEN (2922)	329	0.48	20.562
1940 to today : TS–CREEPING MAHONIA WHITE MEADOWSWEET Fd (2941)	245	0.36	15.312
1940 to today : TS–THIMBLEBERRY PINE GRASS Aw (2952)	358	0.53	22.375
1870 to 1930 : LICHEN LODGEPOLE PINE (811)	7704	11.31	481.5
1870 to 1930 : BEARBERRY/HAIRY WILD RYE LODGEPOLE PINE (821)	4781	7.02	298.812
1870 to 1930 : SUBALPINE LARCH/HEATHER La–Fa (831)	1491	2.19	93.188
1870 to 1930 : SPRUCE/HEATHER Se NORTH (841)	1651	2.42	103.188
1870 to 1930 : FALSE AZALEA/THIMBLEBERRY Pl (851)	25,913	38.04	1619.562
1870 to 1930 : FALSE AZALEA/THIMBLEBERRY Se NORTH (853)	2013	2.96	125.812
1870 to 1930 : FALSE AZALEA/THIMBLEBERRY Fa (854)	1	0	0.062
1870 to 1930 : TS–LIMBER PINE/JUNIPER Fd–Pf (2911)	1727	2.54	107.938
1870 to 1930 : TS–BEARBERRY ASPEN (2922)	139	0.2	8.688
1870 to 1930 : TS–BEARBERRY Aw–Sw–Pl (2923)	1516	2.23	94.75
1870 to 1930 : TS–BUFFALOBERRY HAIRY WILD RYE Fd (2931)	914	1.34	57.125
1870 to 1930 : TS–CREEPING MAHONIA WHITE MEADOWSWEET Fd (2941)	13,782	20.23	861.375
1870 to 1930 : TS–CREEPING MAHONIA WHITE MEADOWSWEET Sw (2943)	299	0.44	18.688
1870 to 1930 : TS–THIMBLEBERRY PINE GRASS Aw (2952)	1618	2.38	101.125
1870 to 1930 : TS–BALSAM POPLAR (2961)	535	0.79	33.438
1870 to 1930 : BEARBERRY Aw–Sw–Pl (923)	1	0	0.062
1870 to 1930 : CREEPING MAHONIA WHITE MEADOWSWEET Fd (941)	1	0	0.062
1870 to 1930 : CREEPING MAHONIA WHITE MEADOWSWEET Pl (942)	12	0.02	0.75
1870 to 1930 : CREEPING MAHONIA WHITE MEADOWSWEET Sw (943)	6	0.01	0.375
1870 to 1930 : BALSAM POPLAR (961)	1	0	0.062
1860 and before : SPRUCE/HEATHER Se NORTH (841)	70	0.1	4.375
1860 and before : FALSE AZALEA/THIMBLEBERRY Se NORTH (853)	2202	3.23	137.625
1860 and before : TS–LIMBER PINE/JUNIPER Fd–Pf (2911)	37	0.05	2.312
1860 and before : TS–BUFFALOBERRY HAIRY WILD RYE Fd (2931)	1	0	0.062
1860 and before : TS–CREEPING MAHONIA WHITE MEADOWSWEET Fd (2941)	190	0.28	11.875
Total	68,113	100	4257.062

Beaver

Class Name	Count	%	Hectares
No Class	29,131	0	1820.688
1940 to today : TS–LIMBER PINE/JUNIPER Fd–Pf (2911)	31	0.04	1.938
1940 to today : TS–BEARBERRY ASPEN (2922)	1044	1.18	65.25
1940 to today : TS–BEARBERRY Aw–Sw–Pl (2923)	1335	1.51	83.438
1940 to today : TS–CREEPING MAHONIA WHITE MEADOWSWEET Fd (2941)	27	0.03	1.688
1940 to today : TS–THIMBLEBERRY PINE GRASS Aw (2952)	1989	2.25	124.312
1940 to today : LIMBER PINE/JUNIPER Fd–Pf (911)	105	0.12	6.562
1940 to today : BEARBERRY ASPEN (922)	244	0.28	15.25
1940 to today : BEARBERRY Aw–Sw–Pl (923)	65	0.07	4.062
1940 to today : CREEPING MAHONIA WHITE MEADOWSWEET Fd (941)	621	0.7	38.812
1940 to today : CREEPING MAHONIA WHITE MEADOWSWEET Pl (942)	294	0.33	18.375
1940 to today : THIMBLEBERRY PINE GRASS Aw (952)	652	0.74	40.75
1870 to 1930 : LICHEN LODGEPOLE PINE (811)	1421	1.6	88.812

1870 to 1930 : BEARBERRY/HAIRY WILD RYE LODGEPOLE PINE (821)	6278	7.09	392.375
1870 to 1930 : FALSE AZALEA/THIMBLEBERRY Pl (851)	11,646	13.15	727.875
1870 to 1930 : FALSE AZALEA/THIMBLEBERRY Se NORTH (853)	217	0.25	13.562
1870 to 1930 : TS—LIMBER PINE/JUNIPER Fd—Pf (2911)	2058	2.32	128.625
1870 to 1930 : TS—BEARBERRY ASPEN (2922)	570	0.64	35.625
1870 to 1930 : TS—BEARBERRY Aw—Sw—Pl (2923)	57	0.06	3.562
1870 to 1930 : TS—BUFFALOBERRY HAIRY WILD RYE Fd (2931)	1602	1.81	100.125
1870 to 1930 : TS—CREEPING MAHONIA WHITE MEADOWSWEET Fd (2941)	1548	1.75	96.75
1870 to 1930 : TS—THIMBLEBERRY PINE GRASS Aw (2952)	655	0.74	40.938
1870 to 1930 : LIMBER PINE/JUNIPER Fd—Pf (911)	3204	3.62	200.25
1870 to 1930 : BEARBERRY LODGEPOLE PINE (921)	4936	5.57	308.5
1870 to 1930 : BEARBERRY ASPEN (922)	577	0.65	36.062
1870 to 1930 : BEARBERRY Aw—Sw—Pl (923)	1448	1.63	90.5
1870 to 1930 : BUFFALOBERRY HAIRY WILD RYE Fd (931)	2693	3.04	168.312
1870 to 1930 : CREEPING MAHONIA WHITE MEADOWSWEET Fd (941)	12,294	13.88	768.375
1870 to 1930 : CREEPING MAHONIA WHITE MEADOWSWEET Pl (942)	18,813	21.24	1175.812
1870 to 1930 : CREEPING MAHONIA WHITE MEADOWSWEET Sw (943)	9208	10.4	575.5
1870 to 1930 : THIMBLEBERRY PINE GRASS Aw (952)	1612	1.82	100.75
1870 to 1930 : BALSAM POPLAR (961)	124	0.14	7.75
1870 to 1930 : TM—FALSE AZALEA/THIMBLEBERRY Fa (2854)	7	0.01	0.438
1860 and before : LIMBER PINE/JUNIPER Fd—Pf (911)	60	0.07	3.75
1860 and before : CREEPING MAHONIA WHITE MEADOWSWEET Fd (941)	1024	1.16	64
1860 and before : CREEPING MAHONIA WHITE MEADOWSWEET Sw (943)	107	0.12	6.688
Total	88,566	100	5535.375

Horseshoe Parkland

Class Name	Count	%	Hectares
No Class	761,891	0	47,618.19
1940 to today : PK—BEARBERRY LODGEPOLE PINE (3921)	269	0.09	16.812
1940 to today : PK—BEARBERRY ASPEN (3922)	34,249	11.02	2140.562
1940 to today : PK—BEARBERRY Aw—Sw—Pl (3923)	2746	0.88	171.625
1940 to today : PK—CREEPING MAHONIA WHITE MEADOWSWEET Fd (3941)	64	0.02	4
1940 to today : PK—CREEPING MAHONIA WHITE MEADOWSWEET Pl (3942)	269	0.09	16.812
1940 to today : PK—CREEPING MAHONIA WHITE MEADOWSWEET Sw (3943)	211	0.07	13.188
1940 to today : PK—THIMBLEBERRY PINE GRASS Aw (3952)	90,073	28.99	5629.562
1940 to today : PK—BALSAM POPLAR (3961)	16,412	5.28	1025.75
1940 to today : PK—HORSETAIL Sw—Pb (3971)	186	0.06	11.625
1940 to today : PK—HORSETAIL Sw (3972)	58	0.02	3.625
1870 to 1930 : CREEPING MAHONIA WHITE MEADOWSWEET Pl (942)	2	0	0.125
1870 to 1930 : PK—LIMBER PINE/JUNIPER Fd—Pf (3911)	205	0.07	12.812
1870 to 1930 : PK—BEARBERRY LODGEPOLE PINE (3921)	2118	0.68	132.375
1870 to 1930 : PK—BEARBERRY ASPEN (3922)	21,475	6.91	1342.188
1870 to 1930 : PK—BEARBERRY Aw—Sw—Pl (3923)	4887	1.57	305.438
1870 to 1930 : PK—BUFFALOBERRY HAIRY WILD RYE—Fd (3931)	340	0.11	21.25
1870 to 1930 : PK—CREEPING MAHONIA WHITE MEADOWSWEET Fd (3941)	3307	1.06	206.688
1870 to 1930 : PK—CREEPING MAHONIA WHITE MEADOWSWEET Pl (3942)	5720	1.84	357.5
1870 to 1930 : PK—CREEPING MAHONIA WHITE MEADOWSWEET Sw (3943)	29,351	9.45	1834.438
1870 to 1930 : PK—THIMBLEBERRY PINE GRASS Aw (3952)	72,514	23.34	4532.125
1870 to 1930 : PK—BALSAM POPLAR (3961)	18,887	6.08	1180.438
1870 to 1930 : PK—HORSETAIL Sw—Pb (3971)	6129	1.97	383.062
1870 to 1930 : PK—HORSETAIL Sw (3972)	997	0.32	62.312
1870 to 1930 : FF—THIMBLEBERRY PINE GRASS Aw (4952)	4	0	0.25
1860 and before : PK—CREEPING MAHONIA WHITE MEADOWSWEET Fd (3941)	215	0.07	13.438
Total	310,688	100	19,418

Saddle Mountain

Class Name	Count	%	Hectares
No Class	48,410	0	3025.625
1940 to today : LIMBER PINE/JUNIPER Fd–Pf (911)	76	0.03	4.75
1940 to today : BEARBERRY ASPEN (922)	10,555	3.97	659.688
1940 to today : BEARBERRY Aw–Sw–Pl (923)	3762	1.42	235.125
1940 to today : CREEPING MAHONIA WHITE MEADOWSWEET Fd (941)	153	0.06	9.562
1940 to today : CREEPING MAHONIA WHITE MEADOWSWEET Pl (942)	70	0.03	4.375
1940 to today : THIMBLEBERRY PINE GRASS Aw (952)	19,058	7.17	1191.125
1940 to today : BALSAM POPLAR (961)	4093	1.54	255.812
1940 to today : HORSETAIL Sw–Pb (971)	202	0.08	12.625
1940 to today : PK–BEARBERRY ASPEN (3922)	1	0	0.062
1870 to 1930 : BEARBERRY/HAIRY WILD RYE LODGEPOLE PINE (821)	4	0	0.25
1870 to 1930 : FALSE AZALEA/THIMBLEBERRY Pl (851)	3	0	0.188
1870 to 1930 : TS–BALSAM POPLAR (2961)	2	0	0.125
1870 to 1930 : LIMBER PINE/JUNIPER Fd–Pf (911)	1995	0.75	124.688
1870 to 1930 : BEARBERRY LODGEPOLE PINE (921)	22,704	8.54	1419
1870 to 1930 : BEARBERRY ASPEN (922)	16,999	6.4	1062.438
1870 to 1930 : BEARBERRY Aw–Sw–Pl (923)	9696	3.65	606
1870 to 1930 : BUFFALOBERRY HAIRY WILD RYE Fd (931)	3326	1.25	207.875
1870 to 1930 : CREEPING MAHONIA WHITE MEADOWSWEET Fd (941)	10,030	3.77	626.875
1870 to 1930 : CREEPING MAHONIA WHITE MEADOWSWEET Pl (942)	66,932	25.19	4183.25
1870 to 1930 : CREEPING MAHONIA WHITE MEADOWSWEET Sw (943)	33,875	12.75	2117.188
1870 to 1930 : THIMBLEBERRY PINE GRASS Aw (952)	37,331	14.05	2333.188
1870 to 1930 : BALSAM POPLAR (961)	18,086	6.81	1130.375
1870 to 1930 : HORSETAIL Sw–Pb (971)	4843	1.82	302.688
1870 to 1930 : HORSETAIL Sw (972)	1742	0.66	108.875
1870 to 1930 : PK–BEARBERRY ASPEN (3922)	1	0	0.062
1870 to 1930 : PK–BEARBERRY Aw–Sw–Pl (3923)	2	0	0.125
1870 to 1930 : PK–CREEPING MAHONIA WHITE MEADOWSWEET Fd (3941)	2	0	0.125
1870 to 1930 : PK–CREEPING MAHONIA WHITE MEADOWSWEET Pl (3942)	4	0	0.25
1870 to 1930 : PK–CREEPING MAHONIA WHITE MEADOWSWEET Sw (3943)	1	0	0.062
1870 to 1930 : PK–THIMBLEBERRY PINE GRASS Aw (3952)	4	0	0.25
1870 to 1930 : PK–BALSAM POPLAR (3961)	5	0	0.312
1870 to 1930 : PK–HORSETAIL Sw–Pb (3971)	3	0	0.188
1860 and before : BEARBERRY LODGEPOLE PINE (921)	30	0.01	1.875
1860 and before : CREEPING MAHONIA WHITE MEADOWSWEET Pl (942)	107	0.04	6.688
1860 and before : CREEPING MAHONIA WHITE MEADOWSWEET Sw (943)	27	0.01	1.688
Total	265,724	100	16,607.75

Whaleback

Class Name	Count	%	Hectares
No Class	247,254	0	15,453.38
1940 to today : LIMBER PINE/JUNIPER Fd–Pf (911)	209	0.05	13.062
1940 to today : BEARBERRY LODGEPOLE PINE (921)	90	0.02	5.625
1940 to today : BEARBERRY ASPEN (922)	6766	1.76	422.875
1940 to today : BEARBERRY Aw–Sw–Pl (923)	1649	0.43	103.062
1940 to today : BUFFALOBERRY HAIRY WILD RYE Fd (931)	99	0.03	6.188
1940 to today : CREEPING MAHONIA WHITE MEADOWSWEET Fd (941)	1124	0.29	70.25
1940 to today : CREEPING MAHONIA WHITE MEADOWSWEET Pl (942)	2706	0.7	169.125
1940 to today : CREEPING MAHONIA WHITE MEADOWSWEET Sw (943)	835	0.22	52.188
1940 to today : THIMBLEBERRY PINE GRASS Aw (952)	11,735	3.05	733.438
1940 to today : BALSAM POPLAR (961)	1453	0.38	90.812
1870 to 1930 : LICHEN LODGEPOLE PINE (811)	14	0	0.875
1870 to 1930 : BEARBERRY/HAIRY WILD RYE LODGEPOLE PINE (821)	7	0	0.438
1870 to 1930 : FALSE AZALEA/THIMBLEBERRY Pl (851)	65	0.02	4.062

1870 to 1930 : FALSE AZALEA/THIMBLEBERRY Se NORTH (853)	11	0	0.688
1870 to 1930 : TS—LIMBER PINE/JUNIPER Fd—Pf (2911)	14	0	0.875
1870 to 1930 : TS—BEARBERRY Aw—Sw—Pl (2923)	1	0	0.062
1870 to 1930 : TS—CREEPING MAHONIA WHITE MEADOWSWEET Fd (2941)	6	0	0.375
1870 to 1930 : TS—THIMBLEBERRY PINE GRASS Aw (2952)	2	0	0.125
1870 to 1930 : TS—BALSAM POPLAR (2961)	9	0	0.562
1870 to 1930 : LIMBER PINE/JUNIPER Fd—Pf (911)	13,407	3.48	837.938
1870 to 1930 : BEARBERRY LODGEPOLE PINE (921)	23,698	6.15	1481.125
1870 to 1930 : BEARBERRY ASPEN (922)	23,139	6.01	1446.188
1870 to 1930 : BEARBERRY Aw—Sw—Pl (923)	13,166	3.42	822.875
1870 to 1930 : BUFFALOBERRY HAIRY WILD RYE Fd (931)	12,386	3.22	774.125
1870 to 1930 : CREEPING MAHONIA WHITE MEADOWSWEET Fd (941)	92,421	24	5776.312
1870 to 1930 : CREEPING MAHONIA WHITE MEADOWSWEET Pl (942)	75,323	19.56	4707.688
1870 to 1930 : CREEPING MAHONIA WHITE MEADOWSWEET Sw (943)	24,450	6.35	1528.125
1870 to 1930 : THIMBLEBERRY PINE GRASS Aw (952)	57,002	14.8	3562.625
1870 to 1930 : BALSAM POPLAR (961)	13,176	3.42	823.5
1870 to 1930 : HORSETAIL Sw—Pb (971)	2005	0.52	125.312
1870 to 1930 : HORSETAIL Sw (972)	583	0.15	36.438
1870 to 1930 : TM—SUBALPINE LARCH/HEATHER La—Fa (2831)	122	0.03	7.625
1870 to 1930 : TM—FALSE AZALEA/THIMBLEBERRY Fa (2854)	325	0.08	20.312
1870 to 1930 : PK—BEARBERRY ASPEN (3922)	25	0.01	1.562
1870 to 1930 : PK—THIMBLEBERRY PINE GRASS Aw (3952)	19	0	1.188
1860 and before : FALSE AZALEA/THIMBLEBERRY Se NORTH (853)	6	0	0.375
1860 and before : LIMBER PINE/JUNIPER Fd—Pf (911)	82	0.02	5.125
1860 and before : CREEPING MAHONIA WHITE MEADOWSWEET Fd (941)	3333	0.87	208.312
1860 and before : CREEPING MAHONIA WHITE MEADOWSWEET Sw (943)	3670	0.95	229.375
Total	385,133	100	24,070.81

Chapel Rock

Class Name	Count	%	Hectares
No Class	328,898	0	20,556.13
1940 to today : TS—BEARBERRY ASPEN (2922)	3	0	0.188
1940 to today : TS—THIMBLEBERRY PINE GRASS Aw (2952)	5	0.01	0.312
1940 to today : LIMBER PINE/JUNIPER Fd—Pf (911)	122	0.14	7.625
1940 to today : BEARBERRY ASPEN (922)	3131	3.54	195.688
1940 to today : BEARBERRY Aw—Sw—Pl (923)	166	0.19	10.375
1940 to today : CREEPING MAHONIA WHITE MEADOWSWEET Fd (941)	428	0.48	26.75
1940 to today : CREEPING MAHONIA WHITE MEADOWSWEET Pl (942)	39	0.04	2.438
1940 to today : THIMBLEBERRY PINE GRASS Aw (952)	12,809	14.48	800.562
1940 to today : BALSAM POPLAR (961)	222	0.25	13.875
1940 to today : FF—THIMBLEBERRY PINE GRASS Aw (4952)	6	0.01	0.375
1870 to 1930 : FALSE AZALEA/THIMBLEBERRY Se NORTH (853)	7	0.01	0.438
1870 to 1930 : LIMBER PINE/JUNIPER Fd—Pf (911)	687	0.78	42.938
1870 to 1930 : BEARBERRY LODGEPOLE PINE (921)	4924	5.57	307.75
1870 to 1930 : BEARBERRY ASPEN (922)	11,652	13.17	728.25
1870 to 1930 : BEARBERRY Aw—Sw—Pl (923)	1258	1.42	78.625
1870 to 1930 : BUFFALOBERRY HAIRY WILD RYE Fd (931)	1195	1.35	74.688
1870 to 1930 : CREEPING MAHONIA WHITE MEADOWSWEET Fd (941)	6612	7.48	413.25
1870 to 1930 : CREEPING MAHONIA WHITE MEADOWSWEET Pl (942)	9189	10.39	574.312
1870 to 1930 : CREEPING MAHONIA WHITE MEADOWSWEET Sw (943)	4421	5	276.312
1870 to 1930 : THIMBLEBERRY PINE GRASS Aw (952)	24,061	27.2	1503.812
1870 to 1930 : BALSAM POPLAR (961)	5911	6.68	369.438
1870 to 1930 : HORSETAIL Sw—Pb (971)	1261	1.43	78.812
1870 to 1930 : TM—FALSE AZALEA/THIMBLEBERRY Fa (2854)	148	0.17	9.25
1870 to 1930 : FF—BEARBERRY ASPEN (4922)	6	0.01	0.375
1870 to 1930 : FF—CREEPING MAHONIA WHITE MEADOWSWEET Fd (4941)	10	0.01	0.625
1870 to 1930 : FF—CREEPING MAHONIA WHITE MEADOWSWEET Sw (4943)	4	0	0.25
1870 to 1930 : FF—THIMBLEBERRY PINE GRASS Aw (4952)	23	0.03	1.438

1870 to 1930 : FF—BALSAM POPLAR (4961)	10	0.01	0.625
1870 to 1930 : FF—HORSETAIL Sw—Pb (4971)	11	0.01	0.688
1860 and before : CREEPING MAHONIA WHITE MEADOWSWEET Sw (943)	133	0.15	8.312
Total	88,454	100	5528.375

South Fescue

Class Name	Count	%	Hectares
No Class	453,579	0	28,348.69
1940 to today : FF—BEARBERRY ASPEN (4922)	113	0.86	7.062
1940 to today : FF—THIMBLEBERRY PINE GRASS Aw (4952)	291	2.21	18.188
1940 to today : FF—BALSAM POPLAR (4961)	138	1.05	8.625
1870 to 1930 : FF—LIMBER PINE/JUNIPER Fd—Pf (4911)	213	1.62	13.312
1870 to 1930 : FF—BEARBERRY ASPEN (4922)	2310	17.58	144.375
1870 to 1930 : FF—BEARBERRY Aw—Sw—Pl (4923)	68	0.52	4.25
1870 to 1930 : FF—BUFFALOBERRY HAIRY WILD RYE—Fd (4931)	54	0.41	3.375
1870 to 1930 : FF—CREEPING MAHONIA WHITE MEADOWSWEET Fd (4941)	1909	14.53	119.312
1870 to 1930 : FF—CREEPING MAHONIA WHITE MEADOWSWEET Sw (4943)	1017	7.74	63.562
1870 to 1930 : FF—THIMBLEBERRY PINE GRASS Aw (4952)	2181	16.6	136.312
1870 to 1930 : FF—BALSAM POPLAR (4961)	2823	21.48	176.438
1870 to 1930 : FF—HORSETAIL Sw—Pb (4971)	1986	15.11	124.125
1870 to 1930 : FF—HORSETAIL Sw (4972)	37	0.28	2.312
Total	13,140	100	821.25

Porcupine Hills

Class Name	Count	%	Hectares
No Class	552,297	0	34,518.56
1940 to today : LIMBER PINE/JUNIPER Fd—Pf (911)	4328	0.58	270.5
1940 to today : BEARBERRY LODGEPOLE PINE (921)	3377	0.45	211.062
1940 to today : BEARBERRY ASPEN (922)	33,595	4.46	2099.688
1940 to today : BEARBERRY Aw—Sw—Pl (923)	10,422	1.38	651.375
1940 to today : BUFFALOBERRY HAIRY WILD RYE Fd (931)	4741	0.63	296.312
1940 to today : CREEPING MAHONIA WHITE MEADOWSWEET Fd (941)	19,986	2.66	1249.125
1940 to today : CREEPING MAHONIA WHITE MEADOWSWEET Pl (942)	5007	0.67	312.938
1940 to today : THIMBLEBERRY PINE GRASS Aw (952)	82,122	10.91	5132.625
1940 to today : BALSAM POPLAR (961)	8032	1.07	502
1940 to today : HORSETAIL Sw—Pb (971)	299	0.04	18.688
1940 to today : TM—FALSE AZALEA/THIMBLEBERRY Fa (2854)	603	0.08	37.688
1940 to today : PK—BEARBERRY ASPEN (3922)	43	0.01	2.688
1940 to today : PK—THIMBLEBERRY PINE GRASS Aw (3952)	2	0	0.125
1940 to today : FF—LIMBER PINE/JUNIPER Fd—Pf (4911)	6	0	0.375
1940 to today : FF—BEARBERRY ASPEN (4922)	6	0	0.375
1940 to today : FF—THIMBLEBERRY PINE GRASS Aw (4952)	90	0.01	5.625
1940 to today : FF—BALSAM POPLAR (4961)	30	0	1.875
1870 to 1930 : LIMBER PINE/JUNIPER Fd—Pf (911)	38,921	5.17	2432.562
1870 to 1930 : BEARBERRY LODGEPOLE PINE (921)	28,102	3.73	1756.375
1870 to 1930 : BEARBERRY ASPEN (922)	25,663	3.41	1603.938
1870 to 1930 : BEARBERRY Aw—Sw—Pl (923)	9888	1.31	618
1870 to 1930 : BUFFALOBERRY HAIRY WILD RYE Fd (931)	34,282	4.55	2142.625
1870 to 1930 : CREEPING MAHONIA WHITE MEADOWSWEET Fd (941)	199,409	26.49	12,463.06
1870 to 1930 : CREEPING MAHONIA WHITE MEADOWSWEET Pl (942)	92,233	12.25	5764.562
1870 to 1930 : CREEPING MAHONIA WHITE MEADOWSWEET Sw (943)	27,485	3.65	1717.812
1870 to 1930 : THIMBLEBERRY PINE GRASS Aw (952)	71,093	9.45	4443.312
1870 to 1930 : BALSAM POPLAR (961)	13,911	1.85	869.438
1870 to 1930 : HORSETAIL Sw—Pb (971)	3023	0.4	188.938
1870 to 1930 : HORSETAIL Sw (972)	442	0.06	27.625

1870 to 1930 : TM—FALSE AZALEA/THIMBLEBERRY Fa (2854)	434	0.06	27.125
1870 to 1930 : PK—BEARBERRY ASPEN (3922)	4	0	0.25
1870 to 1930 : PK—CREEPING MAHONIA WHITE MEADOWSWEET Sw (3943)	1	0	0.062
1870 to 1930 : PK—THIMBLEBERRY PINE GRASS Aw (3952)	30	0	1.875
1870 to 1930 : PK—BALSAM POPLAR (3961)	6	0	0.375
1870 to 1930 : PK—HORSETAIL Sw—Pb (3971)	7	0	0.438
1870 to 1930 : FF—BEARBERRY Aw—Sw—Pl (4923)	1	0	0.062
1870 to 1930 : FF—CREEPING MAHONIA WHITE MEADOWSWEET Sw (4943)	9	0	0.562
1870 to 1930 : FF—THIMBLEBERRY PINE GRASS Aw (4952)	146	0.02	9.125
1870 to 1930 : FF—BALSAM POPLAR (4961)	55	0.01	3.438
1860 and before : LIMBER PINE/JUNIPER Fd—Pf (911)	3619	0.48	226.188
1860 and before : BEARBERRY LODGEPOLE PINE (921)	2191	0.29	136.938
1860 and before : BEARBERRY Aw—Sw—Pl (923)	1	0	0.062
1860 and before : BUFFALOBERRY HAIRY WILD RYE Fd (931)	4040	0.54	252.5
1860 and before : CREEPING MAHONIA WHITE MEADOWSWEET Fd (941)	18,520	2.46	1157.5
1860 and before : CREEPING MAHONIA WHITE MEADOWSWEET Pl (942)	2302	0.31	143.875
1860 and before : CREEPING MAHONIA WHITE MEADOWSWEET Sw (943)	2566	0.34	160.375
1860 and before : THIMBLEBERRY PINE GRASS Aw (952)	381	0.05	23.812
1860 and before : HORSETAIL Sw (972)	1214	0.16	75.875
Total	752,668	100	47,041.75

East Ranchlands

Class Name	Count	%	Hectares
No Class	617,090	0	38,568.13
1940 to today : FF—LIMBER PINE/JUNIPER Fd—Pf (4911)	29	0.14	1.812
1940 to today : FF—BEARBERRY LODGEPOLE PINE (4921)	218	1.02	13.625
1940 to today : FF—BEARBERRY ASPEN (4922)	897	4.21	56.062
1940 to today : FF—BEARBERRY Aw—Sw—Pl (4923)	174	0.82	10.875
1940 to today : FF—CREEPING MAHONIA WHITE MEADOWSWEET Fd (4941)	191	0.9	11.938
1940 to today : FF—CREEPING MAHONIA WHITE MEADOWSWEET Pl (4942)	799	3.75	49.938
1940 to today : FF—THIMBLEBERRY PINE GRASS Aw (4952)	6884	32.34	430.25
1940 to today : FF—BALSAM POPLAR (4961)	3000	14.09	187.5
1870 to 1930 : FF—BEARBERRY LODGEPOLE PINE (4921)	49	0.23	3.062
1870 to 1930 : FF—BEARBERRY ASPEN (4922)	242	1.14	15.125
1870 to 1930 : FF—BEARBERRY Aw—Sw—Pl (4923)	357	1.68	22.312
1870 to 1930 : FF—BUFFALOBERRY HAIRY WILD RYE—Fd (4931)	86	0.4	5.375
1870 to 1930 : FF—CREEPING MAHONIA WHITE MEADOWSWEET Fd (4941)	1862	8.75	116.375
1870 to 1930 : FF—CREEPING MAHONIA WHITE MEADOWSWEET Pl (4942)	182	0.85	11.375
1870 to 1930 : FF—CREEPING MAHONIA WHITE MEADOWSWEET Sw (4943)	1133	5.32	70.812
1870 to 1930 : FF—THIMBLEBERRY PINE GRASS Aw (4952)	1739	8.17	108.688
1870 to 1930 : FF—BALSAM POPLAR (4961)	3447	16.19	215.438
Total	21,289	100	1330.562

APPENDIX 8 Landscape Metrics by Landscape Management Unit

INDICES	**Alpine High Rock**	**Beaver**	**Chapel Rock**
Area Weighted Mean Patch Fractal Dimension	1.27	1.21	1.14
Area Weighted Mean Shape Index	2.41	3.36	10.80
Core Area Coefficient of Variation 1 (%)	1508.50	2533.97	4614.50
Core Area Coefficient of Variation 2 (%)	233.32	297.18	351.34
Core Area Density (#/100 ha)	1.92	2.07	1.65
Core Area Standard Deviation 1 (ha)	2.31	3.95	6.05
Core Area Standard Deviation 2 (ha)	10.76	11.69	17.25
Double Log Fractal Dimension	−23.26	−23.10	−25.41
Edge Density (m/ha)	174.01	157.24	178.40
FREQUENCY	1540.00	3537.00	13,639.00
LCAS	8.87	8.15	8.11
Largest Patch Index (%)	5.74	10.68	18.35
Landscape Shape Index	25.28	36.46	74.59
MAX−AREA_HA	152.19	721.25	4031.63
Mean Core Area 1 (ha)	0.15	0.16	0.13
Mean Core Area 2 (ha)	4.61	3.93	4.91
Mean Core Index (%)	0.24	0.16	0.07
Mean Patch Fractal Dimension	1.41	1.41	1.42
Mean Patch Size (ha)	1.72	1.91	1.61
Mean Shape Index	1.47	1.47	1.41
Modified Simpson's Diversity Index	1.63	2.51	0.98
Modified Simpson's Eveness Index	0.51	0.71	0.28
Number of Core Areas	51.00	140.00	363.00
Number of Patches	1540.00	3537.00	13,639.00
Patch Density (#/100 ha)	58.08	52.36	62.09
Patch Richness	24.00	35.00	33.00
Patch Richness Density (#/100 ha)	0.91	0.52	0.15
Patch Size Coefficient of Variation (%)	414.98	772.83	2356.80
Patch Size Standard Deviation (ha)	7.15	14.76	37.97
Relative Patch Richness (%)	64.87	94.60	89.19
Shannon's Diversity Index	2.12	2.88	1.45
Shannon's Eveness Index	0.67	0.81	0.41
Simpson's Diversity Index	0.80	0.92	0.63
Simpson's Eveness Index	0.84	0.95	0.65
STD−AREA_HA	7.15	14.76	37.97
STD−CORE	2.31	3.95	6.05
STD−CORE_AREA_HA	10.76	11.69	17.25
Sum Area (ha)	2651.32	6754.09	21,963.09
SUM−CAI	375.30	578.79	995.65
SUM−CORE	235.26	550.73	1782.43
SUM−FRACT	2168.28	4985.89	19,372.57
SUM−LN_1PERIM	8600.24	19,637.71	71,775.94
SUM−LN_2PERIM	17,200.48	39,275.41	143,551.89
SUM−LN_AP	71,085.40	161,163.44	550,952.94
SUM−LN_AREA	12,254.29	27,939.74	101,191.31
SUM−L_FRACT_AW	1.27	1.21	1.14
SUM−L_SHAPE_AW	2.41	3.36	10.80
SUM−NCORE	51.00	140.00	363.00
SUM−SHAPEI	2257.44	5201.53	19,274.18
Total Area (ha)	2651.32	6754.09	21,963.09
Total Core Area (ha)	235.26	550.73	1782.43
Total Core Area Index (%)	8.87	8.15	8.12
Total Edge (km)	461.40	1062.10	3918.85

INDICES	Crowsnest Pass	East Ranchlands	Flathead
Area Weighted Mean Patch Fractal Dimension	1.29	1.33	1.29
Area Weighted Mean Shape Index	3.18	6.62	2.79
Core Area Coefficient of Variation 1 (%)	1170.32	1268.72	1252.72
Core Area Coefficient of Variation 2 (%)	231.97	613.61	196.87
Core Area Density (#/100 ha)	2.19	0.76	2.33
Core Area Standard Deviation 1 (ha)	1.81	334.07	2.99
Core Area Standard Deviation 2 (ha)	6.52	472.90	8.29
Double Log fractal Dimension	−20.04	−15.06	−21.10
Edge Density (m/ha)	153.71	37.88	140.51
FREQUENCY	2360.00	761.00	1355.00
LCAS	6.14	58.21	9.79
Largest Patch Index (%)	3.82	30.30	7.89
Landscape Shape Index	33.44	19.82	22.81
MAX−AREA_HA	227.00	10,431.50	261.13
Mean Core Area 1 (ha)	0.16	26.33	0.24
Mean Core Area 2 (ha)	2.81	77.07	4.21
Mean Core Index (%)	0.25	2.92	0.34
Mean Patch Fractal Dimension	1.41	1.39	1.41
Mean Patch Size (ha)	2.52	45.24	2.44
Mean Shape Index	1.52	1.81	1.48
Modified Simpson's Diversity Index	2.25	1.08	2.33
Modified Simpson's Eveness Index	0.61	0.37	0.72
Number of Core Areas	130.00	260.00	77.00
Number of Patches	2360.00	761.00	1355.00
Patch Density (#/100 ha)	39.69	2.21	40.92
Patch Richness	39.00	19.00	25.00
Patch Richness Density (#/100 ha)	0.66	0.06	0.76
Patch Size Coefficient of Variation (%)	421.36	1028.26	463.87
Patch Size Standard Deviation (ha)	10.61	465.14	11.34
Relative Patch Richness (%)	105.41	51.35	67.57
Shannon's Diversity Index	2.65	1.35	2.59
Shannon's Eveness Index	0.72	0.46	0.80
Simpson's Diversity Index	0.89	0.66	0.90
Simpson's Eveness Index	0.92	0.70	0.94
STD−AREA_HA	10.61	465.14	11.34
STD−CORE	1.81	334.07	2.99
STD−CORE_AREA_HA	6.52	472.90	8.29
Sum Area (ha)	5945.60	34,424.54	3311.51
SUM−CAI	595.96	2224.20	460.12
SUM−CORE	365.21	20,037.83	324.08
SUM−FRACT	3321.27	1056.51	1904.21
SUM−LN_1PERIM	13,366.52	4898.99	7631.65
SUM−LN_2PERIM	26,733.04	9797.99	15,263.30
SUM−LN_AP	112,828.82	48,575.89	64,022.40
SUM−LN_AREA	19,058.32	7097.05	10,900.63
SUM−L_FRACT_AW	1.29	1.33	1.29
SUM−L_SHAPE_AW	3.18	6.62	2.79
SUM−NCORE	130.00	260.00	77.00
SUM−SHAPEI	3574.52	1378.65	2000.31
Total Area (ha)	5945.60	34,424.54	3311.51
Total Core Area (ha)	365.21	20,037.83	324.08
Total Core Area Index (%)	6.14	58.21	9.79
Total Edge (km)	913.95	1303.83	465.33

INDICES	Head Water Valleys	Hillcrest	Horseshoe
Area Weighted Mean Patch Fractal Dimension	1.19	1.32	1.08
Area Weighted Mean Shape Index	5.02	5.61	5.32
Core Area Coefficient of Variation 1 (%)	2105.72	2164.24	2694.35
Core Area Coefficient of Variation 2 (%)	477.02	431.59	369.28
Core Area Density (#/100 ha)	2.08	2.45	2.09
Core Area Standard Deviation 1 (ha)	26.87	7.45	9.05
Core Area Standard Deviation 2 (ha)	54.40	22.24	25.32
Double Log fractal Dimension	18.81	−22.32	−22.14
Edge Density (m/ha)	92.59	129.24	141.77
FREQUENCY	6211.00	1635.00	19,571.00
LCAS	23.77	12.63	14.32
Largest Patch Index (%)	8.12	19.27	4.61
Landscape Shape Index	47.69	24.32	85.73
MAX−AREA_HA	2707.88	857.63	2117.38
Mean Core Area 1 (ha)	1.28	0.34	0.34
Mean Core Area 2 (ha)	11.41	5.15	6.86
Mean Core Index (%)	0.60	0.20	0.24
Mean Patch Fractal Dimension	1.40	1.41	1.42
Mean Patch Size (ha)	5.37	2.72	2.35
Mean Shape Index	1.53	1.47	1.45
Modified Simpson's Diversity Index	1.71	1.33	1.36
Modified Simpson's Eveness Index	0.48	0.37	0.42
Number of Core Areas	695.00	109.00	960.00
Number of Patches	6211.00	1635.00	19,571.00
Patch Density (#/100 ha)	18.63	36.75	42.59
Patch Richness	35.00	38.00	26.00
Patch Richness Density (#/100 ha)	0.11	0.85	0.06
Patch Size Coefficient of Variation (%)	1079.99	1108.27	1181.64
Patch Size Standard Deviation (ha)	57.97	30.16	27.75
Relative Patch Richness (%)	94.60	102.70	70.27
Shannon's Diversity Index	2.09	1.98	1.61
Shannon's Eveness Index	0.59	0.54	0.50
Simpson's Diversity Index	0.82	0.74	0.74
Simpson's Eveness Index	0.84	0.76	0.77
STD−AREA_HA	57.97	30.16	27.74
STD−CORE	26.87	7.45	9.05
STD−CORE_AREA_HA	54.40	22.24	25.31
Sum Area (ha)	33,341.81	4449.29	45,949.70
SUM−CAI	3711.96	318.59	4596.04
SUM−CORE	7926.29	561.79	6581.06
SUM−FRACT	8715.75	2305.62	27,756.77
SUM−LN_1PERIM	35,705.77	9037.42	105,180.66
SUM−LN_2PERIM	71,411.54	18,074.84	210,361.32
SUM−LN_AP	307,966.62	73,898.62	830,581.04
SUM−LN_AREA	51,094.58	12,852.60	148,580.58
SUM−L_FRACT_AW	1.19	1.32	1.08
SUM−L_SHAPE_AW	5.02	5.61	5.32
SUM−NCORE	695.00	109.00	960.00
SUM−SHAPEI	9513.04	2397.83	28,464.74
Total Area (ha)	33,341.81	4449.29	45,949.70
Total Core Area (ha)	7926.29	561.79	6581.06
Total Core Area Index (%)	23.77	12.63	14.32
Total Edge (km)	3087.05	575.08	6514.78

INDICES	Ironstone	Livingstone Valley	Middle Ridges
Area Weighted Mean Patch Fractal Dimension	1.36	1.27	0.91
Area Weighted Mean Shape Index	8.73	3.39	4.58
Core Area Coefficient of Variation 1 (%)	2868.77	1839.72	3204.34
Core Area Coefficient of Variation 2 (%)	434.16	222.44	383.53
Core Area Density (#/100 ha)	1.70	2.52	2.00
Core Area Standard Deviation 1 (ha)	51.81	3.94	12.56
Core Area Standard Deviation 2 (ha)	74.32	7.14	30.47
Double Log fractal Dimension	−20.13	−19.90	−22.84
Edge Density (m/ha)	82.46	138.68	130.04
FREQUENCY	1346.00	2678.00	28,984.00
LCAS	29.06	8.10	15.86
Largest Patch Index (%)	50.61	7.98	4.33
Landscape Shape Index	21.28	32.94	98.13
MAX−AREA_HA	4233.44	565.44	3099.06
Mean Core Area 1 (ha)	1.81	0.21	0.39
Mean Core Area 2 (ha)	17.12	3.21	7.94
Mean Core Index (%)	0.50	0.26	0.21
Mean Patch Fractal Dimension	1.41	1.41	1.41
Mean Patch Size (ha)	6.22	2.65	2.47
Mean Shape Index	1.52	1.51	1.45
Modified Simpson's Diversity Index	1.07	1.71	1.73
Modified Simpson's Eveness Index	0.30	0.53	0.48
Number of Core Areas	142.00	179.00	1429.00
Number of Patches	1346.00	2678.00	28,984.00
Patch Density (#/100 ha)	16.09	37.77	40.50
Patch Richness	34.00	26.00	37.00
Patch Richness Density (#/100 ha)	0.41	0.37	0.05
Patch Size Coefficient of Variation (%)	1871.05	585.05	1357.92
Patch Size Standard Deviation (ha)	116.29	15.49	33.53
Relative Patch Richness (%)	91.89	70.27	100.00
Shannon's Diversity Index	1.73	2.04	2.29
Shannon's Eveness Index	0.49	0.63	0.63
Simpson's Diversity Index	0.66	0.82	0.82
Simpson's Eveness Index	0.68	0.85	0.85
STD−AREA_HA	116.29	15.49	33.53
STD−CORE	51.81	3.94	12.56
STD−CORE_AREA_HA	74.32	7.14	30.47
Sum Area (ha)	8365.00	7090.14	71,555.22
SUM−CAI	672.03	707.81	5958.38
SUM−CORE	2430.77	574.24	11,352.51
SUM−FRACT	1891.27	3775.48	40,885.17
SUM−LN_1PERIM	7663.66	15,029.89	159,485.72
SUM−LN_2PERIM	15,327.33	30,059.78	318,971.44
SUM−LN_AP	65,142.57	125,487.83	1,296,558.88
SUM−LN_AREA	10,947.35	21,386.90	226,738.12
SUM−L_FRACT_AW	1.36	1.27	0.91
SUM−L_SHAPE_AW	8.73	3.39	4.58
SUM−NCORE	142.00	179.00	1429.00
SUM−SHAPEI	2043.79	4040.56	42,130.22
Total Area (ha)	8365.00	7090.14	71,555.22
Total Core Area (ha)	2430.77	574.24	11,352.51
Total Core Area Index (%)	29.06	8.10	15.87

Total Edge (km)	689.80	983.35	9305.48

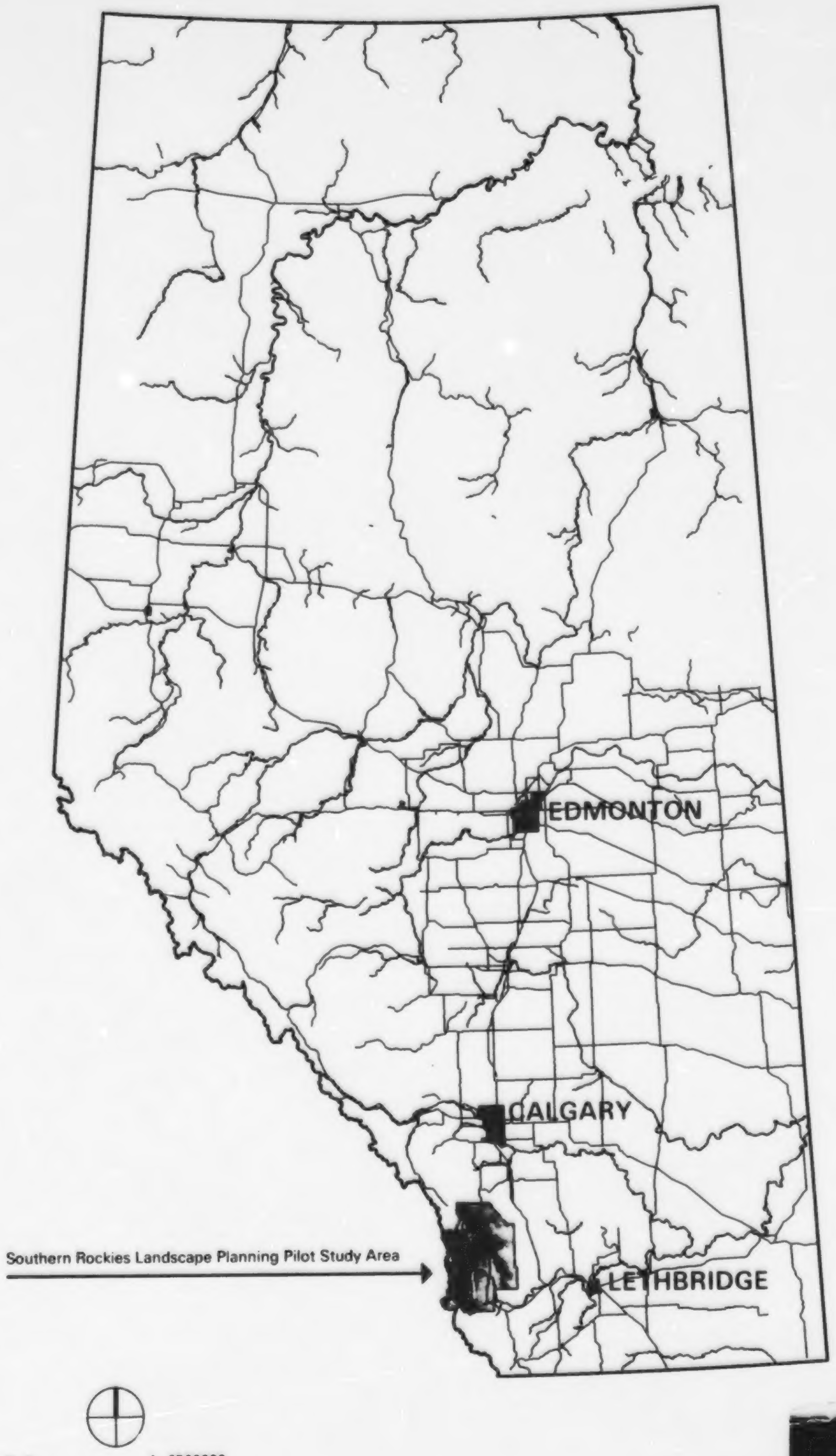
INDICES	**North Livingstone**	**Porcupine Hills**	**Saddle Mountain**
Area Weighted Mean Patch Fractal Dimension	0.94	0.93	1.16
Area Weighted Mean Shape Index	3.20	6.49	5.20
Core Area Coefficient of Variation 1 (%)	2286.06	4199.23	1993.38
Core Area Coefficient of Variation 2 (%)	265.45	416.41	315.87
Core Area Density (#/100 ha)	2.04	2.09	2.60
Core Area Standard Deviation 1 (ha)	3.77	10.92	5.72
Core Area Standard Deviation 2 (ha)	12.39	24.96	11.39
Double Log fractal Dimension	−24.29	−23.10	−20.43
Edge Density (m/ha)	161.27	145.73	132.50
FREQUENCY	20,639.00	37,206.00	6383.00
LCAS	9.51	12.50	9.38
Largest Patch Index (%)	2.02	3.99	5.81
Landscape Shape Index	86.10	114.30	52.24
MAX−AREA_HA	724.00	3082.75	1134.81
Mean Core Area 1 (ha)	0.17	0.26	0.29
Mean Core Area 2 (ha)	4.67	5.99	3.61
Mean Core Index (%)	0.15	0.16	0.24
Mean Patch Fractal Dimension	1.41	1.42	1.41
Mean Patch Size (ha)	1.74	2.08	3.06
Mean Shape Index	1.45	1.42	1.51
Modified Simpson's Diversity Index	2.04	1.72	1.59
Modified Simpson's Eveness Index	0.57	0.48	0.45
Number of Core Areas	730.00	1612.00	508.00
Number of Patches	20,639.00	37,206.00	6383.00
Patch Density (#/100 ha)	57.62	48.13	32.68
Patch Richness	35.00	36.00	35.00
Patch Richness Density (#/100 ha)	0.10	0.05	0.18
Patch Size Coefficient of Variation (%)	777.13	1524.50	876.67
Patch Size Standard Deviation (ha)	13.49	31.68	26.83
Relative Patch Richness (%)	94.60	97.30	94.60
Shannon's Diversity Index	2.42	2.02	2.02
Shannon's Eveness Index	0.68	0.56	0.57
Simpson's Diversity Index	0.87	0.82	0.80
Simpson's Eveness Index	0.90	0.84	0.82
STD−AREA_HA	13.49	31.68	26.83
STD−CORE	3.77	10.92	5.72
STD−CORE_AREA_HA	12.39	24.96	11.39
Sum Area (ha)	35,815.72	77,296.81	19,530.42
SUM−CAI	3094.14	6018.55	1535.31
SUM−CORE	3407.30	9662.45	1832.54
SUM−FRACT	29,154.72	52,749.73	8986.53
SUM−LN_1PERIM	112,755.05	197,847.25	35,973.10
SUM−LN_2PERIM	225,510.10	395,694.49	71,946.19
SUM−LN_AP	906,335.52	1,543,847.62	301,685.39
SUM−LN_AREA	160,013.29	279,639.42	51,258.75
SUM−L_FRACT_AW	0.94	0.93	1.16
SUM−L_SHAPE_AW	3.20	6.49	5.20
SUM−NCORE	730.00	1612.00	508.00
SUM−SHAPEI	29,837.83	52,817.65	9645.49
Total Area (ha)	35,815.72	77,296.81	19,530.42
Total Core Area (ha)	3407.30	9662.45	1832.54

Total Core Area Index (%)	9.51	12.50	9.38
Total Edge (km)	5776.53	11,265.23	2587.90

INDICES	**South Fescue**	**South Livingstone**	**Whaleback**
Area Weighted Mean Patch Fractal Dimension	1.31	1.27	1.02
Area Weighted Mean Shape Index	3.89	3.07	5.06
Core Area Coefficient of Variation 1 (%)	860.42	1400.77	2787.85
Core Area Coefficient of Variation 2 (%)	445.48	293.66	472.84
Core Area Density (#/100 ha)	1.18	2.51	2.07
Core Area Standard Deviation 1 (ha)	109.53	3.66	5.97
Core Area Standard Deviation 2 (ha)	186.81	12.62	22.46
Double Log fractal Dimension	–14.08	–20.55	–22.31
Edge Density (m/ha)	48.55	140.90	148.28
FREQUENCY	672.00	2236.00	16,648.00
LCAS	49.43	10.76	9.85
Largest Patch Index (%)	15.85	5.14	6.25
Landscape Shape Index	18.02	29.29	79.55
MAX–AREA_HA	2742.00	278.94	2261.56
Mean Core Area 1 (ha)	12.73	0.26	0.21
Mean Core Area 2 (ha)	41.93	4.30	4.75
Mean Core Index (%)	3.54	0.30	0.15
Mean Patch Fractal Dimension	1.39	1.41	1.41
Mean Patch Size (ha)	25.75	2.43	2.17
Mean Shape Index	1.70	1.45	1.46
Modified Simpson's Diversity Index	0.97	1.96	1.92
Modified Simpson's Eveness Index	0.34	0.58	0.54
Number of Core Areas	204.00	136.00	750.00
Number of Patches	672.00	2236.00	16,648.00
Patch Density (#/100 ha)	3.88	41.19	46.04
Patch Richness	18.00	30.00	36.00
Patch Richness Density (#/100 ha)	0.10	0.55	0.10
Patch Size Coefficient of Variation (%)	628.19	520.22	1108.89
Patch Size Standard Deviation (ha)	161.76	12.63	24.09
Relative Patch Richness (%)	48.65	81.08	97.30
Shannon's Diversity Index	1.35	2.40	2.19
Shannon's Eveness Index	0.47	0.71	0.61
Simpson's Diversity Index	0.62	0.86	0.85
Simpson's Eveness Index	0.66	0.89	0.88
STD–AREA_HA	161.76	12.63	24.08
STD–CORE	109.53	3.66	5.97
STD–CORE_AREA_HA	186.81	12.62	22.46
Sum Area (ha)	17,304.67	5428.36	36,158.48
SUM–CAI	2377.20	678.10	2560.24
SUM–CORE	8554.37	584.35	3562.03
SUM–FRACT	935.28	3150.40	23,535.86
SUM–LN_1PERIM	4191.28	12,368.04	90,754.33
SUM–LN_2PERIM	8382.55	24,736.08	181,508.67
SUM–LN_AP	40,338.06	101,699.86	729,633.45
SUM–LN_AREA	6063.02	17,617.77	128,693.13
SUM–L_FRACT_AW	1.31	1.27	1.02
SUM–L_SHAPE_AW	3.89	3.07	5.06
SUM–NCORE	204.00	136.00	750.00
SUM–SHAPEI	1143.38	3251.42	24,251.56
Total Area (ha)	17,304.67	5428.36	36,158.48

List of Maps

STUDY AREA
DIGITAL ELEVATION MODEL
SLOPE POSITION
NATURAL SUB REGIONS
LANDSCAPE MANAGEMENT UNITS
FOREST ORIGINS
OLD GROWTH FORESTS — 200 YRS+
MATURITY CLASSES
SUCCESSIONAL STAGES
FIRE — 1890 to 1920
FIRES GREATER THAN 1000 HECTARES
DISTURBANCE PATCH SIZE
OIL AND GAS FOOTPRINT
FORESTED LANDBASE
LAND COVER
FORESTED ONLY PATCH SIZE
ECOSITES
ECOSITE PHASE (Vegetation x Site Type)
CURRENT ECOSITE PHASE PATCH SIZE
ECOSITE PHASE DIVERSITY
PATCH CIRCULARITY — FOREST ORIGIN
PATCH COMPACTNESS — FOREST ORIGIN
PATCH CIRCULARITY — ECOSITE PHASE
PATCH COMPACTNESS — ECOSITE PHASE
STREAM SIDE VEGETATION
LANDSCAPE PATTERN


EDMONTON
CALGARY
Southern Rockies Landscape Planning Pilot Study Area
LETHBRIDGE
Scale
1 : 3500000
100
0
Kilometers

STUDY AREA CONTEXT

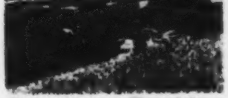
Alberta
Environmental Protection

Southern Rockies
Landscape Planning Pilot Study

October 29, 1987

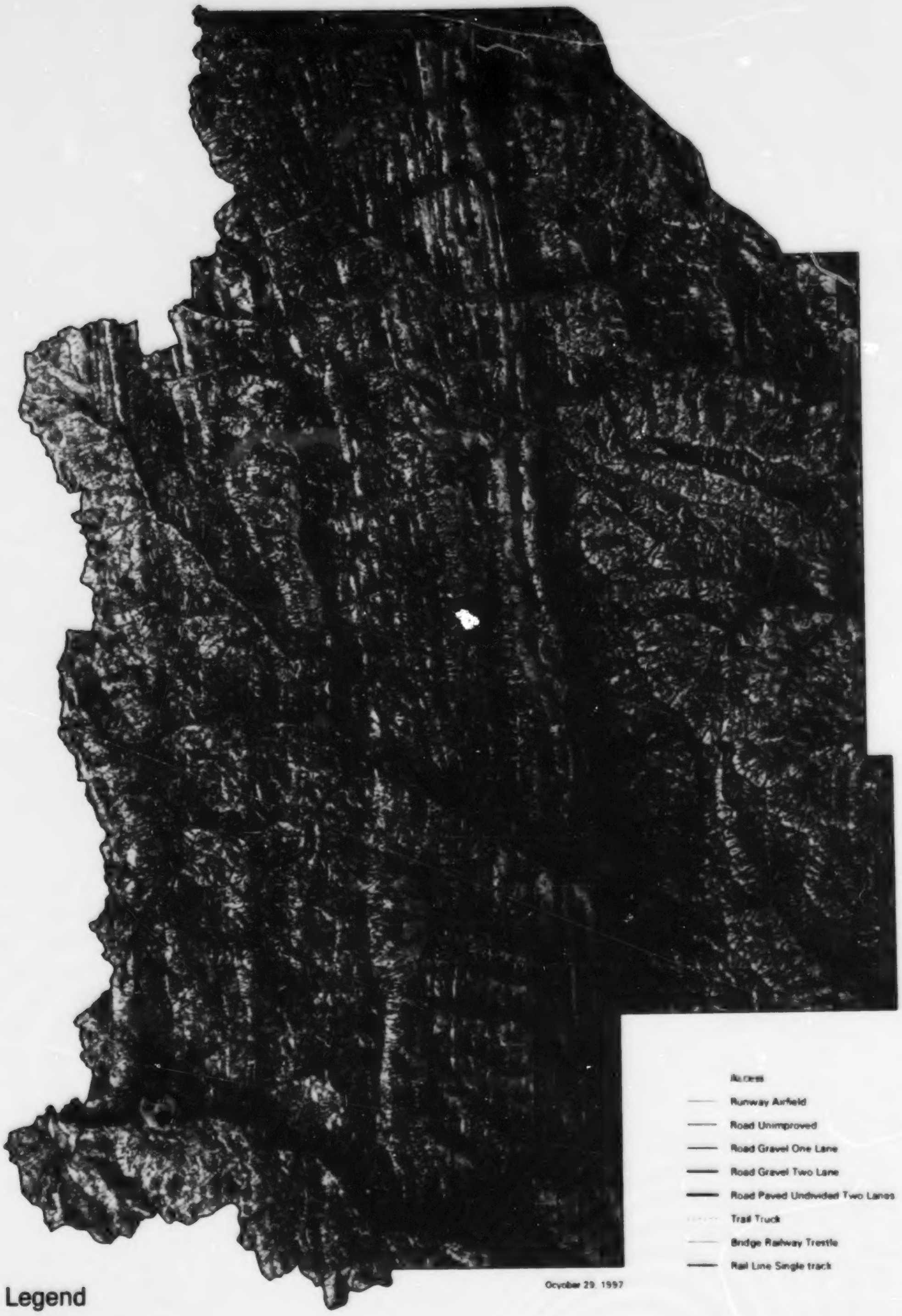
Alberta
Environmental Protection

Scale 1 : 300 000
Kilometers
5 0 2



Southern Rockies Landscape Planning Pilot Study

DIGITAL ELEVATION MODEL



Access

- Runway Airfield
- Road Unimproved
- Road Gravel One Lane
- Road Gravel Two Lane
- Road Paved Undivided Two Lanes
- Trail Truck
- Bridge Railway Trestle
- Rail Line Single track

Ocyober 29 1997

Legend

■ Ridges and Crests

■ Incised Valleys and Valley Edges

▨ Slopes

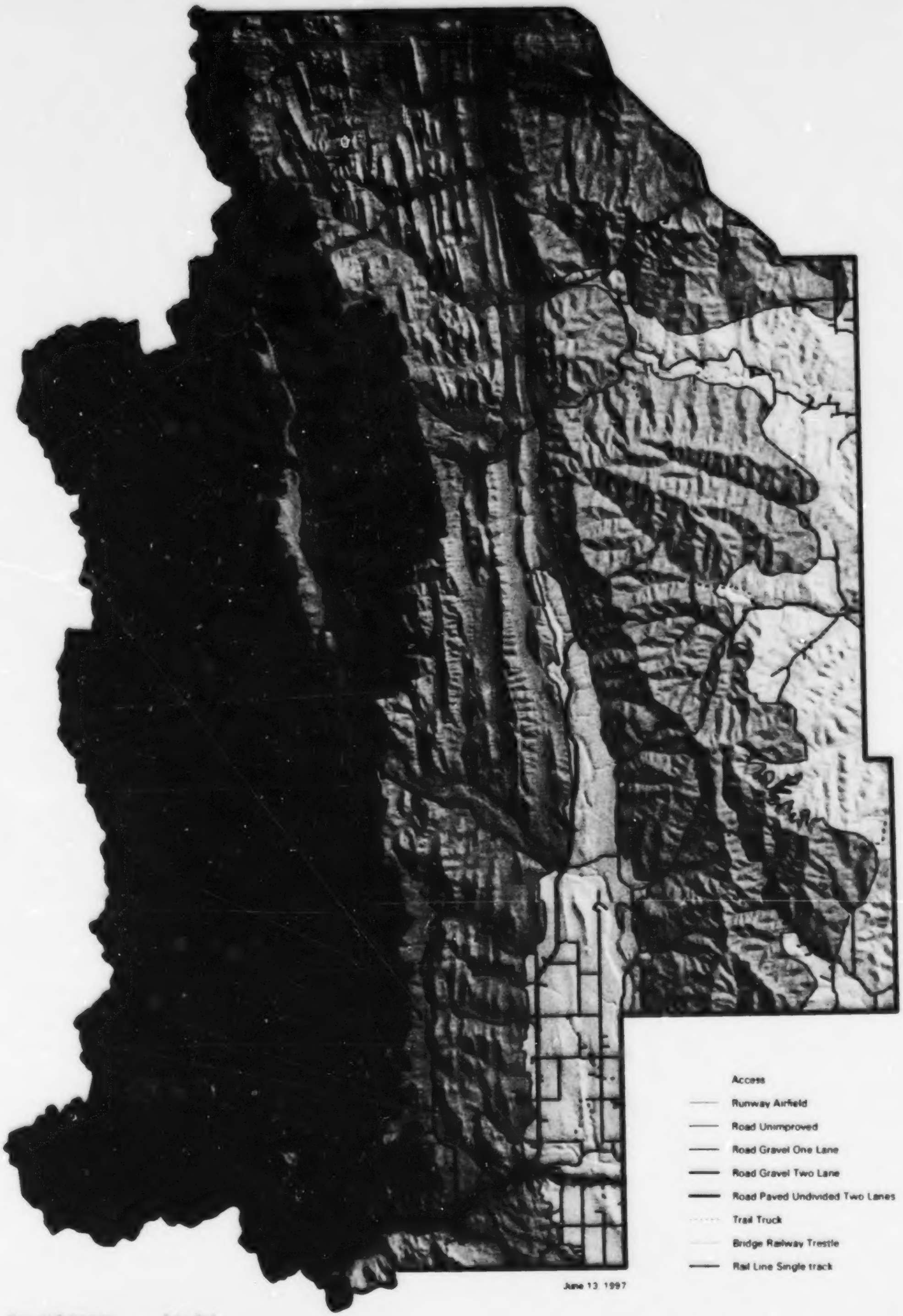
▨ Flat Valley Bottoms

SLOPE POSITION

Alberta
Environmental Protection

Scale 1 300 000
5 0 2 Kilometers

Southern Rockies
Landscape Planning Pilot Study

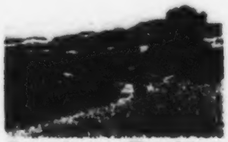

Access
Runway Airfield
Road Unimproved
Road Gravel One Lane
Road Gravel Two Lane
Road Paved Undivided Two Lanes
Trail Truck
Bridge Railway Trestle
Rail Line Single track

June 13 1997

	Natural Subregion	Area (ha)
■	Alpine	13142
▨	Subalpine	170309
▩	Montane	185977
■	Foothills Parkland	87062
☐	Foothills Fescue	89314

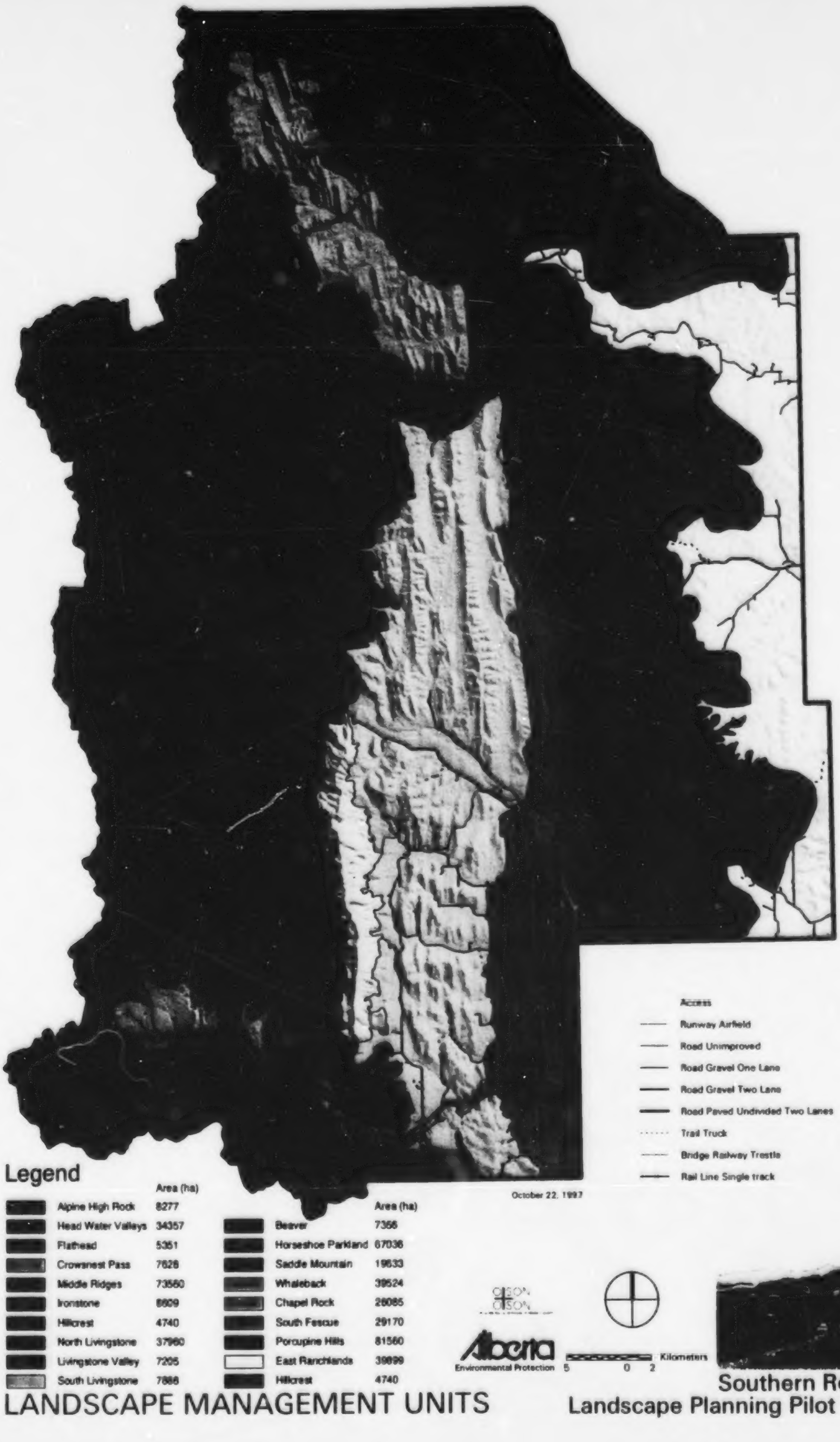
Alberta
Environmental Protection

Kilometers
5 0 2



Southern Rockies
Landscape Planning Pilot Study

NATURAL SUBREGIONS


Access
Runway Airfield
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Road Gravel Two Lane
Road Paved Undivided Two Lanes
Trail Truck
Bridge Railway Trestle
Rail Line Single track

October 22, 1997

Legend

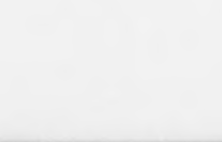
		Area (ha)			Area (ha)
■	Alpine High Rock	8277			
■	Head Water Valleys	34357	■	Beaver	7366
■	Flathead	5351	■	Horseshoe Parkland	67036
■	Crowsnest Pass	7628	■	Saddle Mountain	19633
■	Middle Ridges	73560	■	Whaleback	39524
■	Ironstone	8609	■	Chapel Rock	26085
■	Hillcrest	4740	■	South Fescue	29170
■	North Livingstone	37960	■	Porcupine Hills	81560
■	Livingstone Valley	7205	☐	East Ranchlands	39899
■	South Livingstone	7886	■	Hillcrest	4740

LANDSCAPE MANAGEMENT UNITS

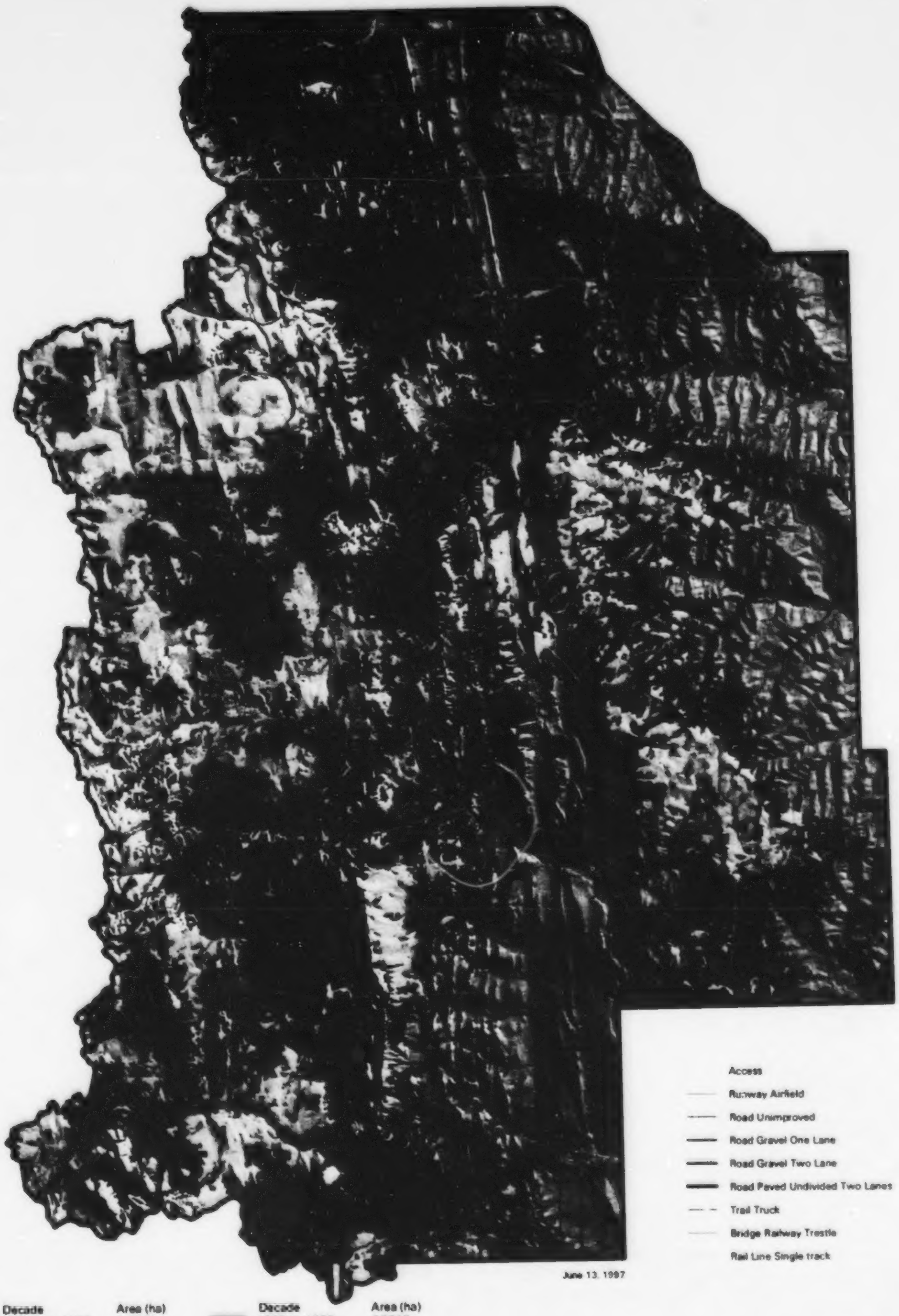
OLSON + OLSON

Alberta
Environmental Protection

5 0 2 Kilometers



Southern Rockies
Landscape Planning Pilot Study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Runway Airfield
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Bridge Railway Trestle
Rail Line Single track

June 13, 1997

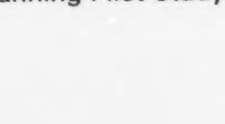
	Decade	Area (ha)
■	older than 1789	13020
■	1790 to 1799	2080
■	1800 to 1809	3654
■	1810 to 1819	625
■	1820 to 1829	1168
□	1830 to 1839	491
■	1840 to 1849	3158
■	1850 to 1859	1404
▨	1860 to 1869	7372
□	1870 to 1879	18035
□	1880 to 1889	15359

	Decade	Area (ha)
■	1890 to 1899	27743
■	1900 to 1909	20416
■	1910 to 1919	58953
▨	1920 to 1929	38530
□	1930 to 1939	24426
■	1940 to 1949	15372
■	1950 to 1959	8856
■	1960 to 1969	5225
■	1970 to 1979	2531
■	1980 to 1990	868

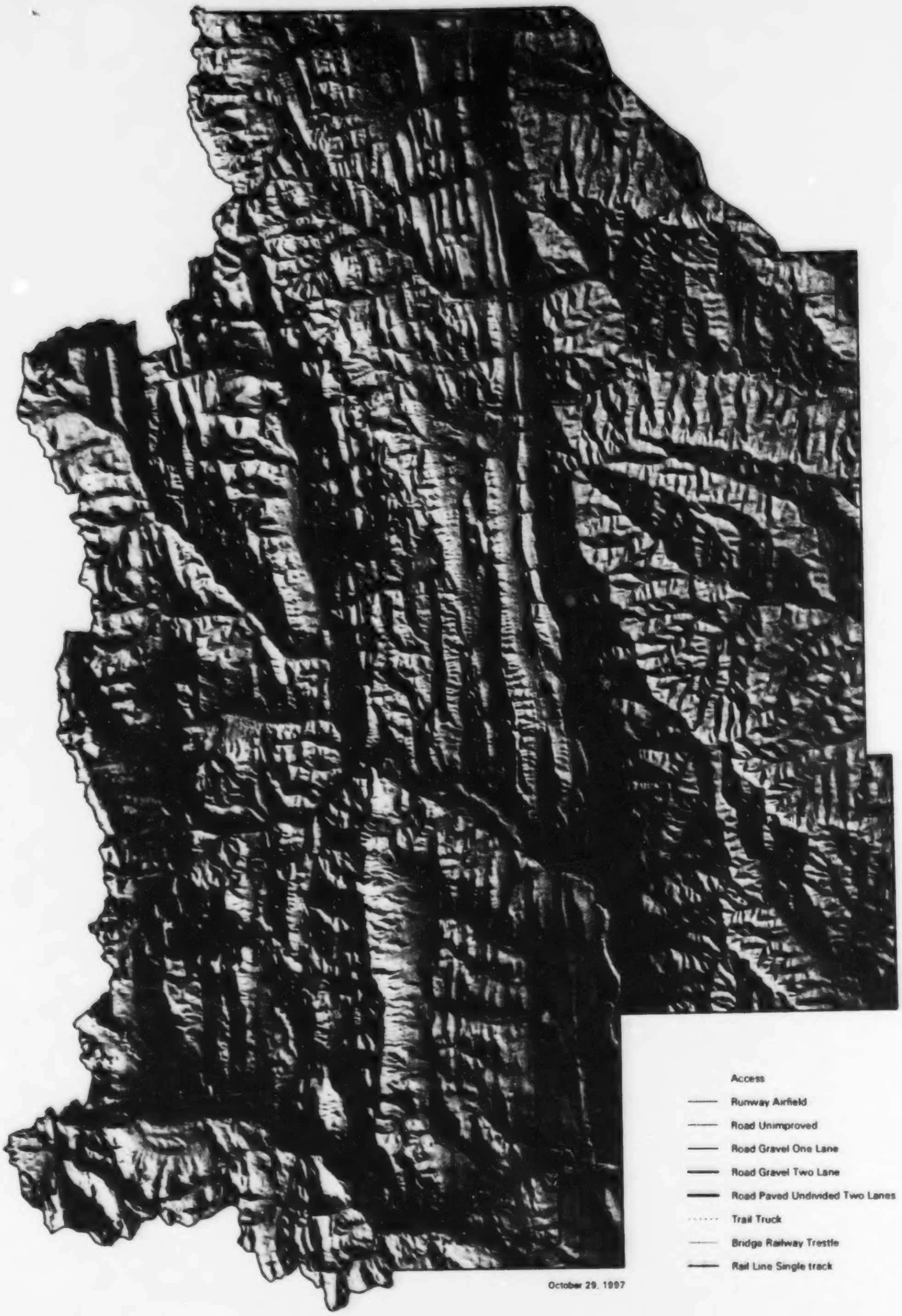
FOREST ORIGINS

Alberta
Environmental Protection

5 0 2 Kilometers



Southern Rockies
Landscape Planning Pilot Study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October 29, 1997

Legend

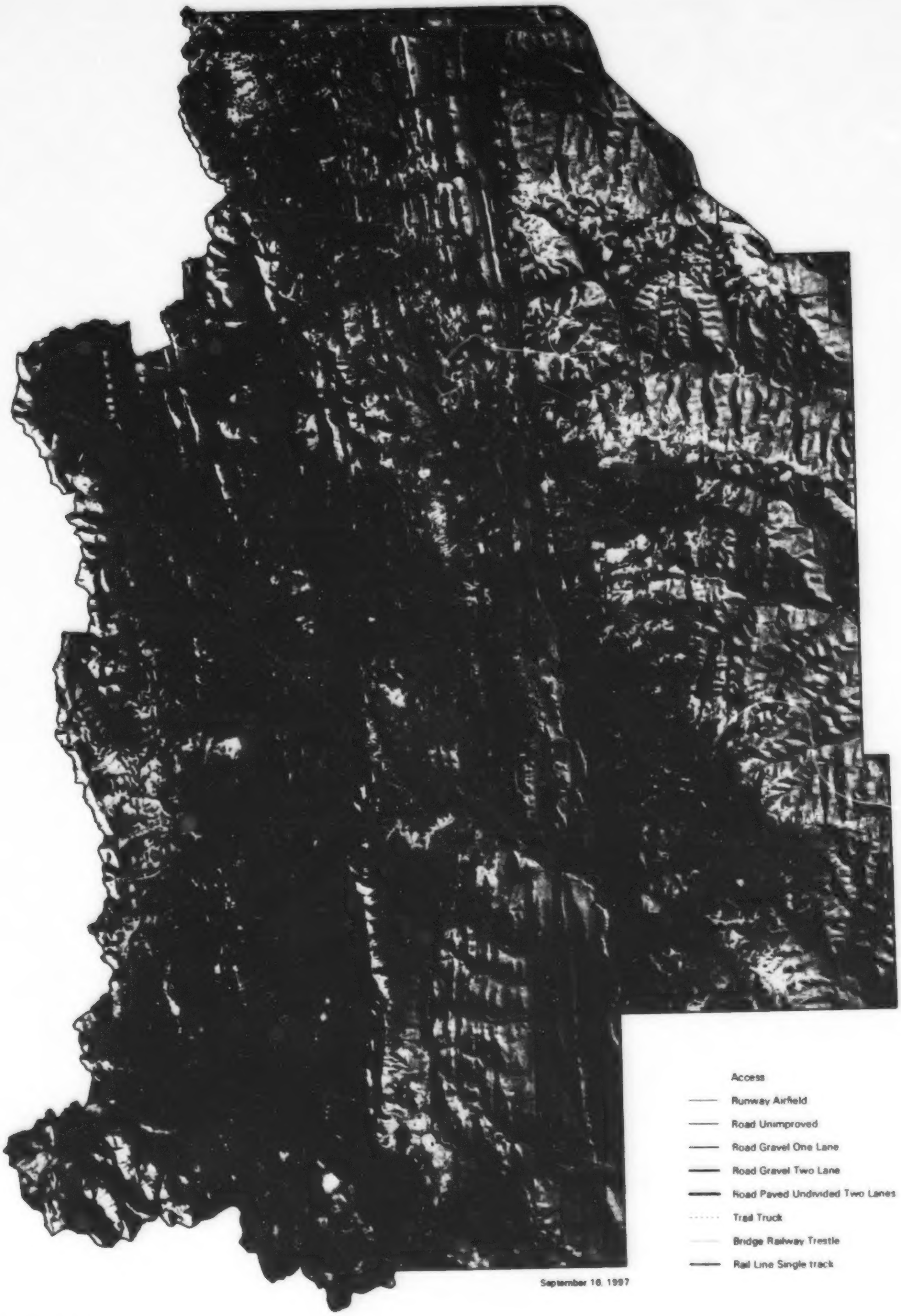
▇ 15100 HECTARES

Alberta
Environmental Protection

Scale 1 : 300 000
5 0 2 Kilometers

Southern Rockies
Landscape Planning Pilot Study

OLD GROWTH FORESTS - 200 YEARS and OLDER



Access

Runway Airfield

Road Unimproved

Road Gravel One Lane

Road Gravel Two Lane

Road Paved Undivided Two Lanes

Trail Truck

Bridge Railway Trestle

Rail Line Single track

September 16, 1997

Legend

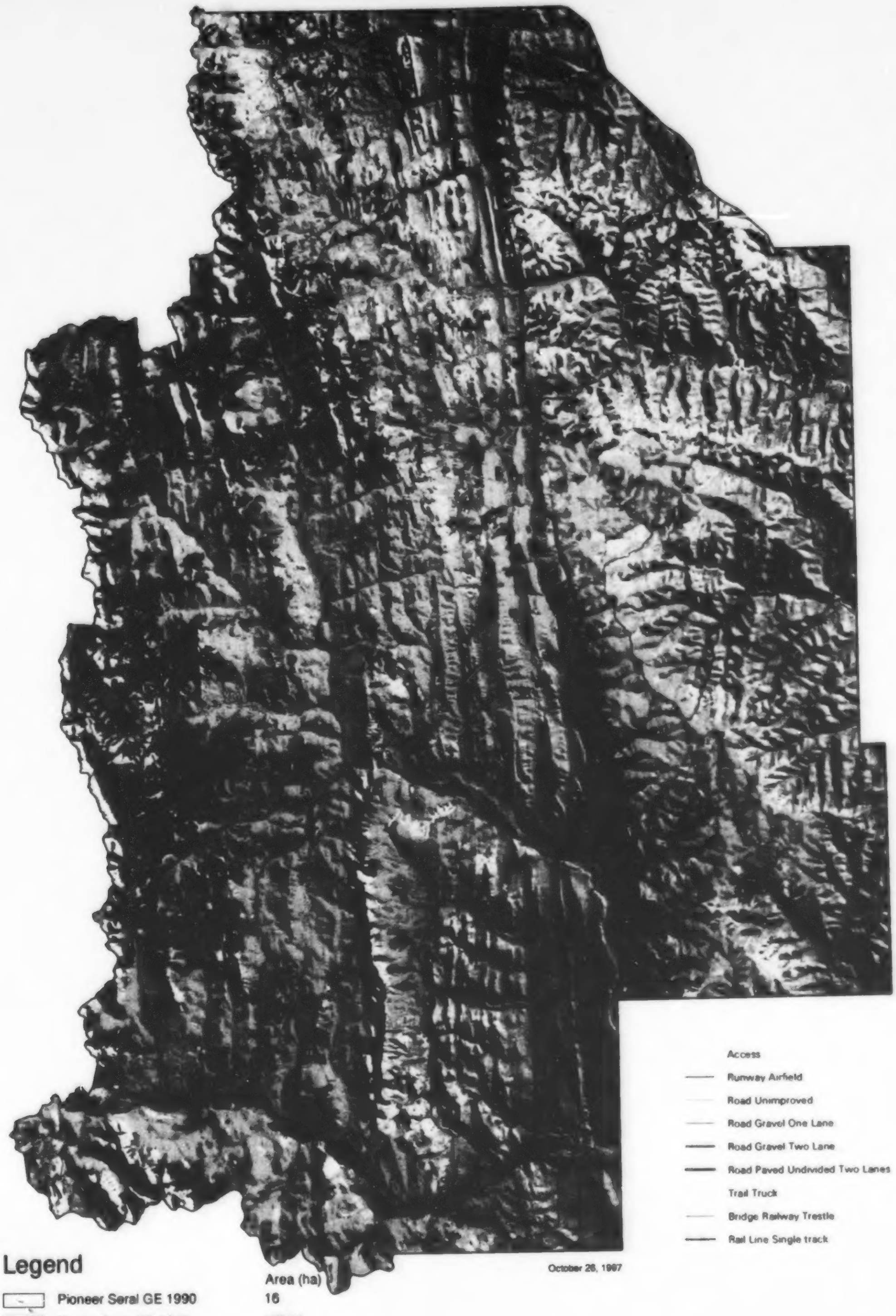
		Area (ha)
▨	YOUNG - 1940 to today	32864
■	MATURE - 1870 to 1930	202928
■	OLD - 1860 and before	32034

MATURITY CLASSES

Alberta
Environmental Protection

5 0 2 Kilometers

Southern Rockies
Landscape Planning Pilot Study


Access
Runway Airfield
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Trail Truck
Bridge Railway Trestle
Rail Line Single track

October 26, 1997

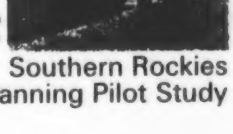
Legend

		Area (ha)
☐	Pioneer Seral GE 1990	16
▨	Young Seral GE 1940	18275
■	Maturing Seral LT 1940 GE 1860	114763
■	Old Seral LT 1860	4549
▨	Young Edaphic Climax GE 1940	10840
■	Mature Edaphic Climax LT 1940	62380
■	Young Climactic Climax GE 1940	3733
■	Mature Climactic Climax LT 1940	53271

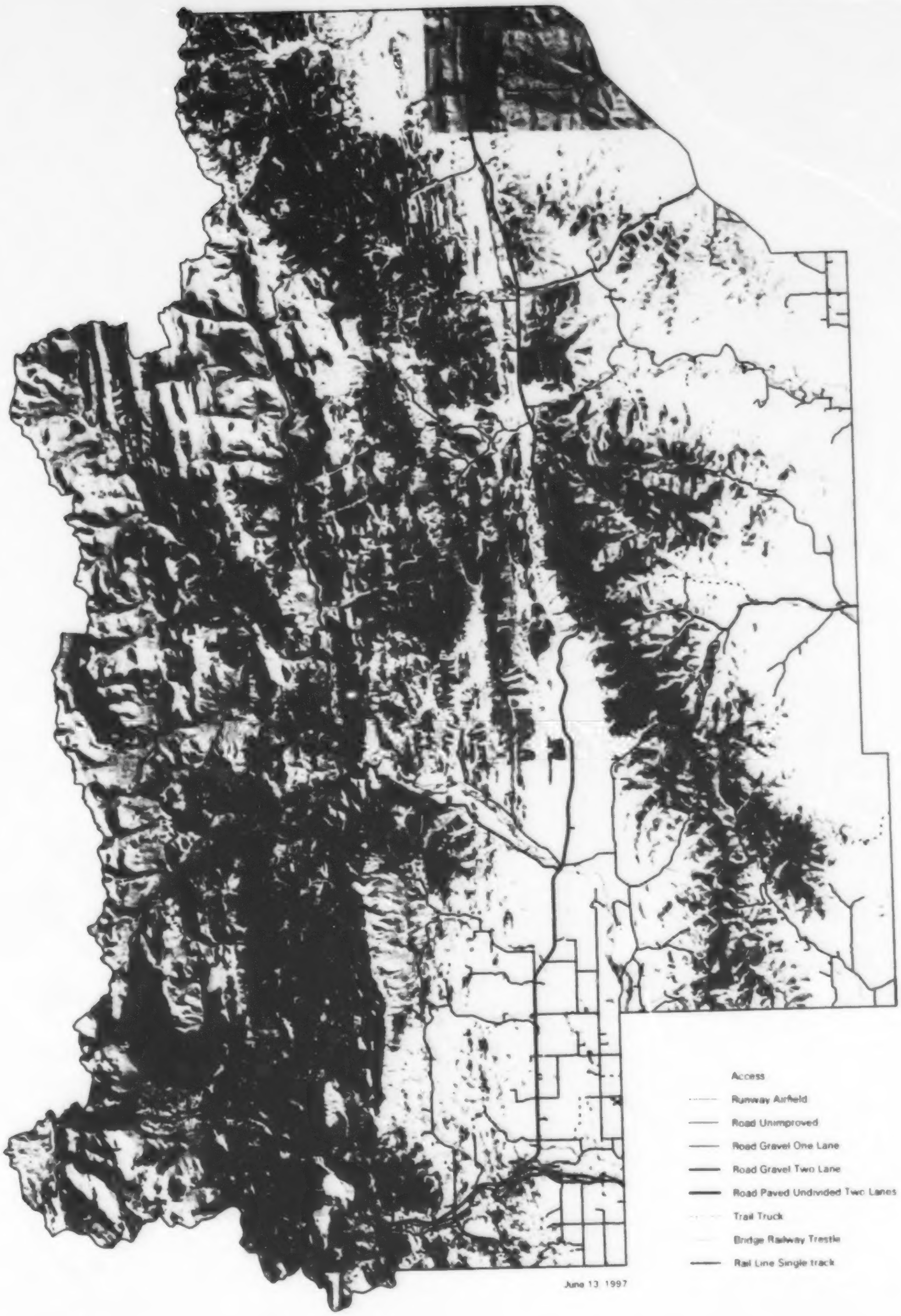
SUCCESSIONAL STAGES

Alberta
Environmental Protection

Scale 1 : 300 000
Kilometers
5 0 2



Southern Rockies
Landscape Planning Pilot Study


Access
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Rail Line Single track
June 13 1997

Legend

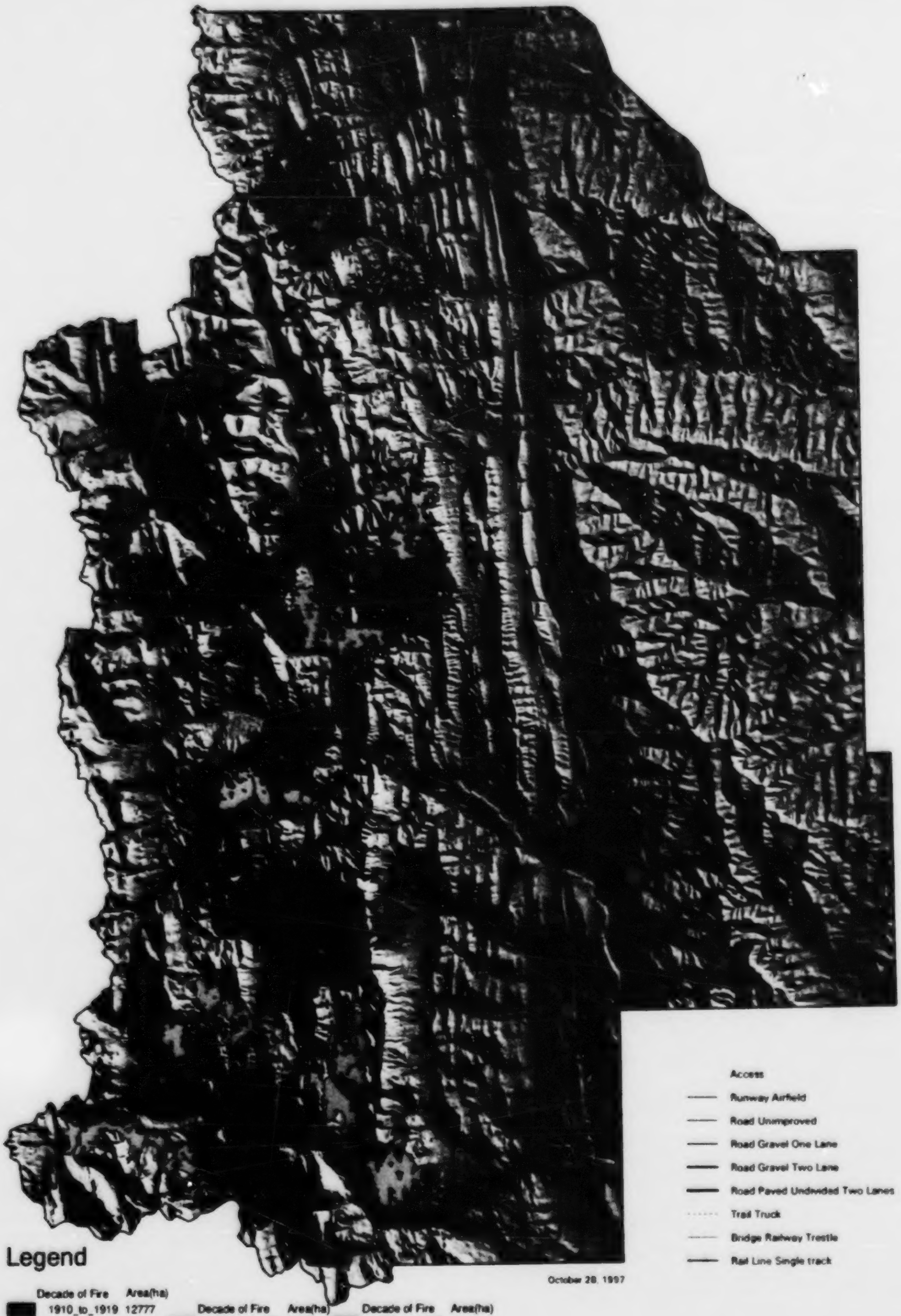
- ▇ Area of Burn 1890 to 1920
- ☐ Grassland/Shrub Areas (fire history not recorded)

FIRE - 1890 to 1920

Alberta
Environmental Protection

5 0 2 Kilometers

Southern Rockies
Landscape Planning Pilot Study



Legend

	Decade of Fire	Area(ha)
■	1910_to_1919	12777
■	1910_to_1919	4372
■	1910_to_1919	4185
■	1860_to_1869	3893
■	1910_to_1919	3479
■	1900_to_1909	3162
■	1920_to_1929	2351
■	1890_to_1899	2197
▨	1900_to_1909	2141

	Decade of Fire	Area(ha)
▨	1870_to_1879	2062
▨	1930_to_1939	1939
▨	1930_to_1939	1836
▨	1930_to_1939	1771
□	1920_to_1929	1699
□	1920_to_1929	1610
□	1920_to_1929	1517
□	1920_to_1929	1485

	Decade of Fire	Area(ha)
■	1880_to_1889	1451
■	1920_to_1929	1345
■	1880_to_1889	1235
■	1870_to_1879	1192
■	1870_to_1879	1173
■	1880_to_1889	1071
▨	1880_to_1889	1058
□	1920_to_1929	1029

Access

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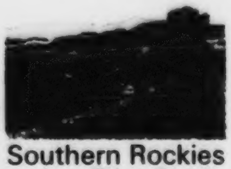
October 28, 1997

OLSON
OLSON

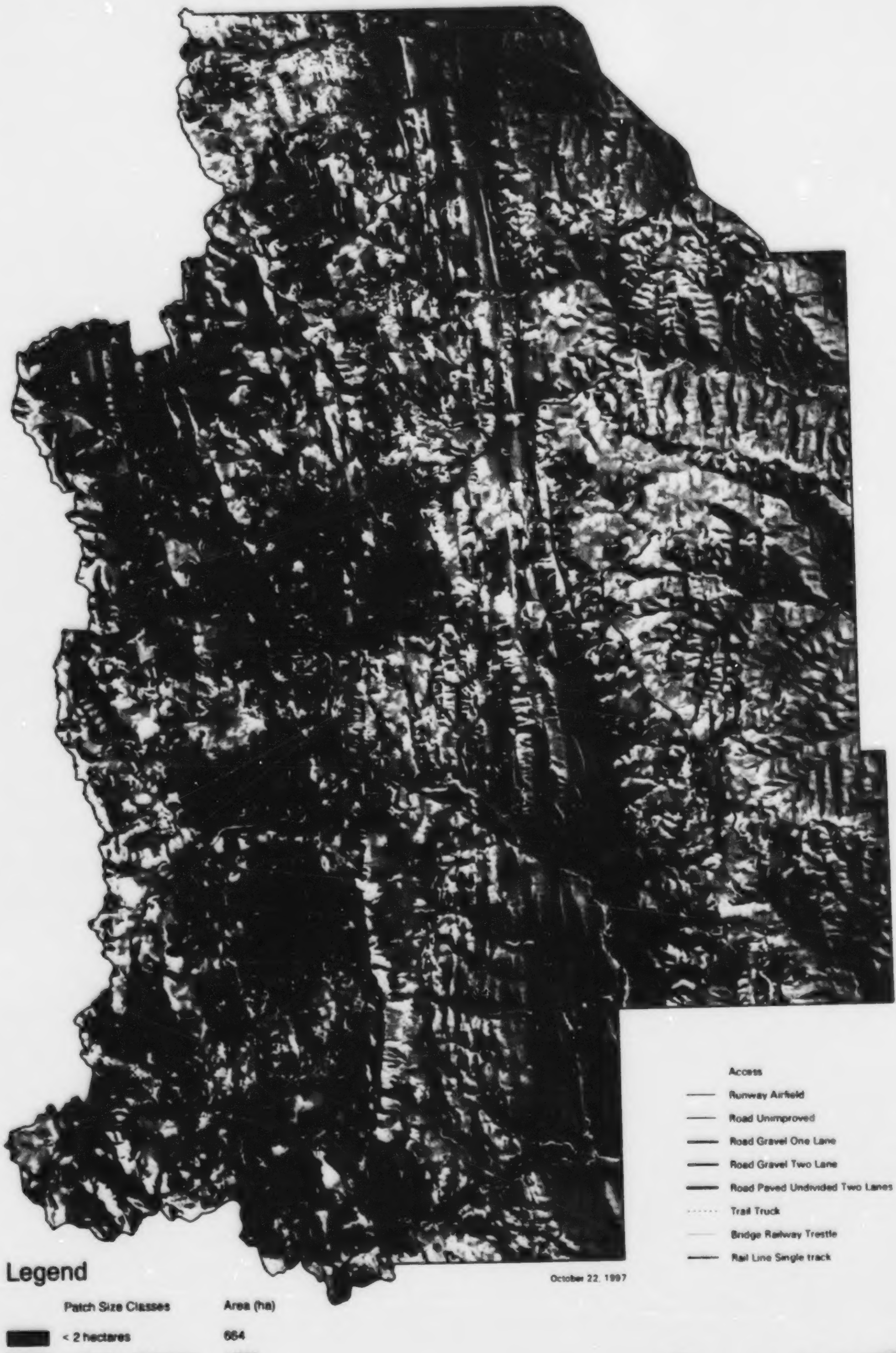
Alberta
Environmental Protection

Scale 1 : 300 000
5 0 2 Kilometers



FIRES GREATER THAN 1000 HECTARES

Southern Rockies
Landscape Planning Pilot Study



October 22, 1997

Access

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- Road Unimproved
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- Bridge Railway Trestle
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Legend

	Patch Size Classes	Area (ha)
■	< 2 hectares	664
☐	>= 2 and <= 10 hectares	14502
☐	> 10 and <= 50 hectares	58643
■	> 50 and <= 250 hectares	74222
■	> 250 and <= 1000 hectares	56666
■	> 1000 hectares	64740

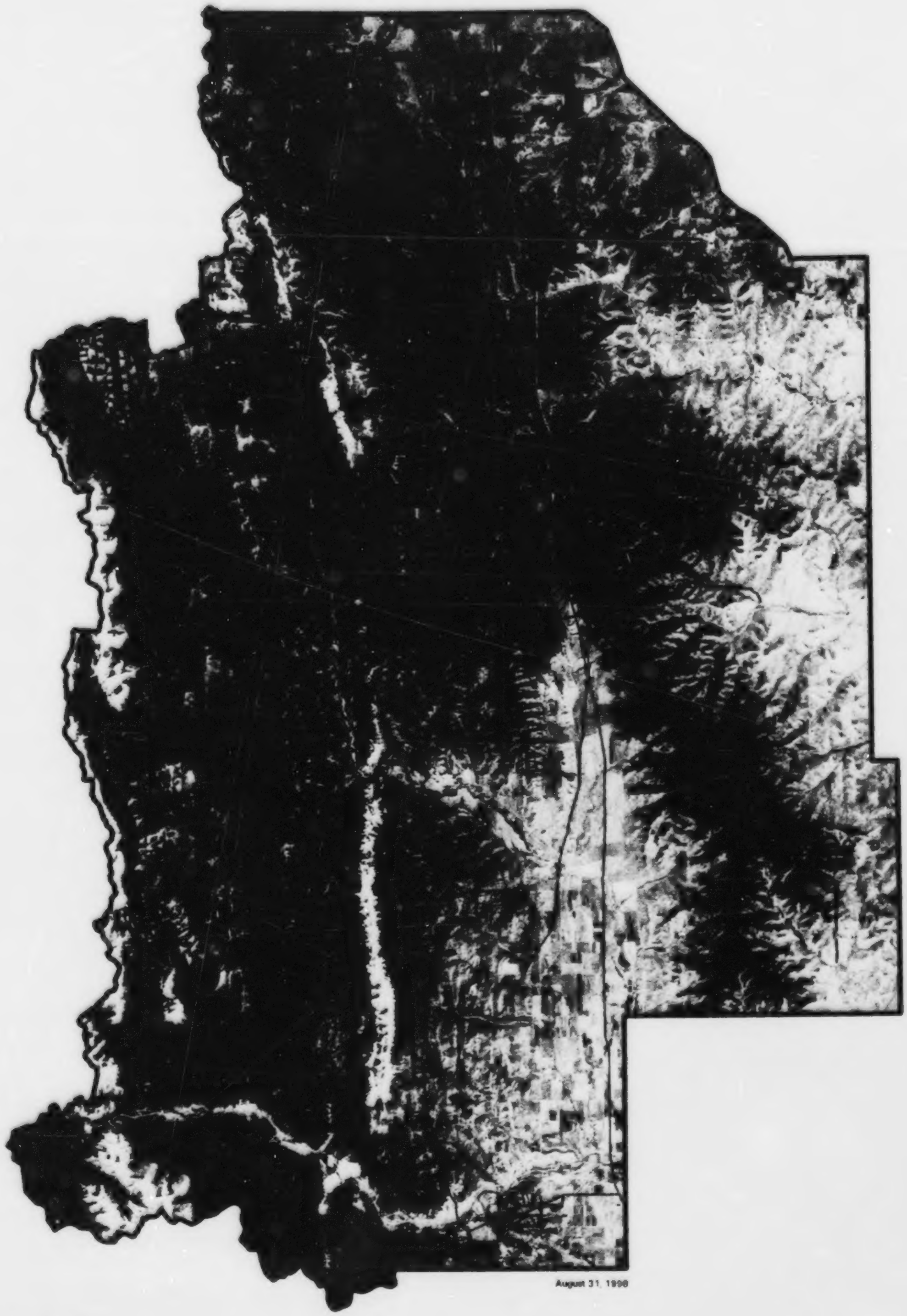
DISTURBANCE PATCH SIZE

OLSON + OLSON

Alberta
Environmental Protection

5 0 2 Kilometers

Southern Rockies
Landscape Planning Pilot Study



August 31, 1998

Legend

───	Access associated with oil and gas exploration and development
───	Major Pipeline
•	Wellsite

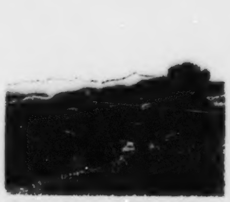
Landsat TM Image: August 9, 1996

OIL and GAS FOOTPRINT

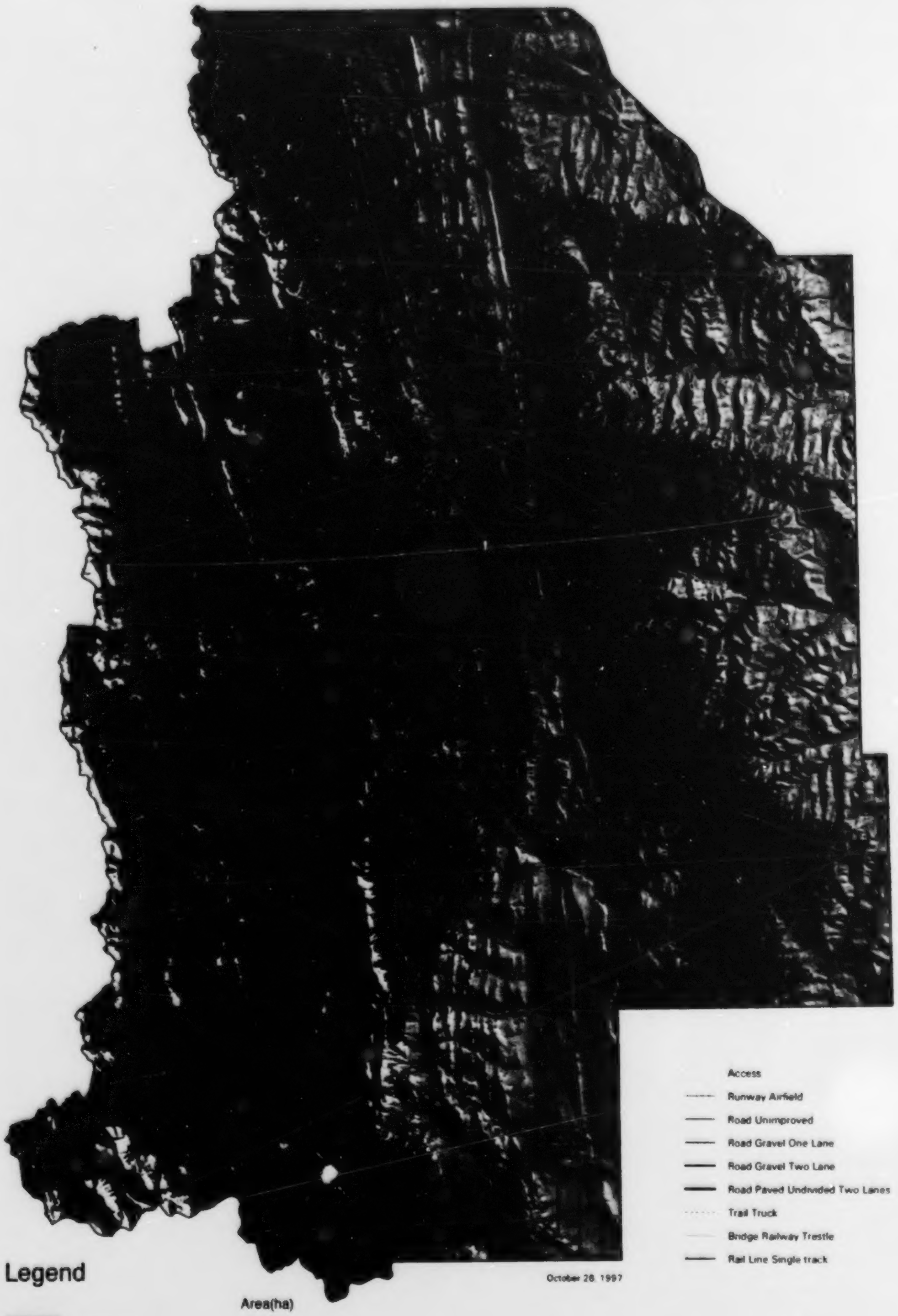
OLSON OLSON

Alberta Environmental Protection

Scale 1 : 300 000
5 0 2 Kilometers



Southern Rockies Landscape Planning Pilot Study



Access

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October 28 1997

Legend

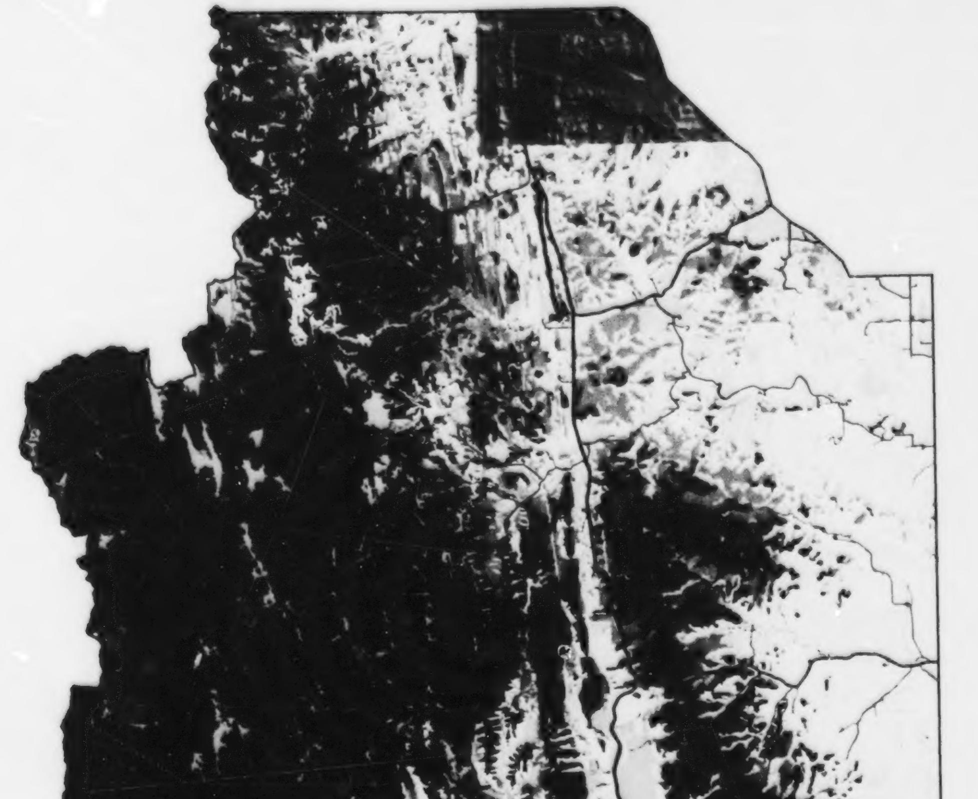
		Area(ha)
■	Coniferous	205120
■	Coniferous-Deciduous	5420
■	Deciduous-Coniferous	9436
■	Deciduous	49376
☐	Other	222724

FORESTED LAND BASE

Alberta
Environmental Protection

Scale 1 300 000
5 0 2 Kilometers

Southern Rockies Landscape Planning Pilot Study


Access
Runway Airfield
Road Unimproved
Road Gravel One Lane
Road Gravel Two Lane
Road Paved Undivided Two Lanes
Trail Truck
Bridge Railway Trestle
Rail Line Single track

September 15, 1997

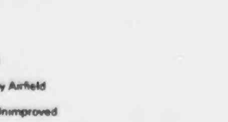
Legend

Delineation of the 51 classes of Land Cover is available digitally.

OLSON
OLSON

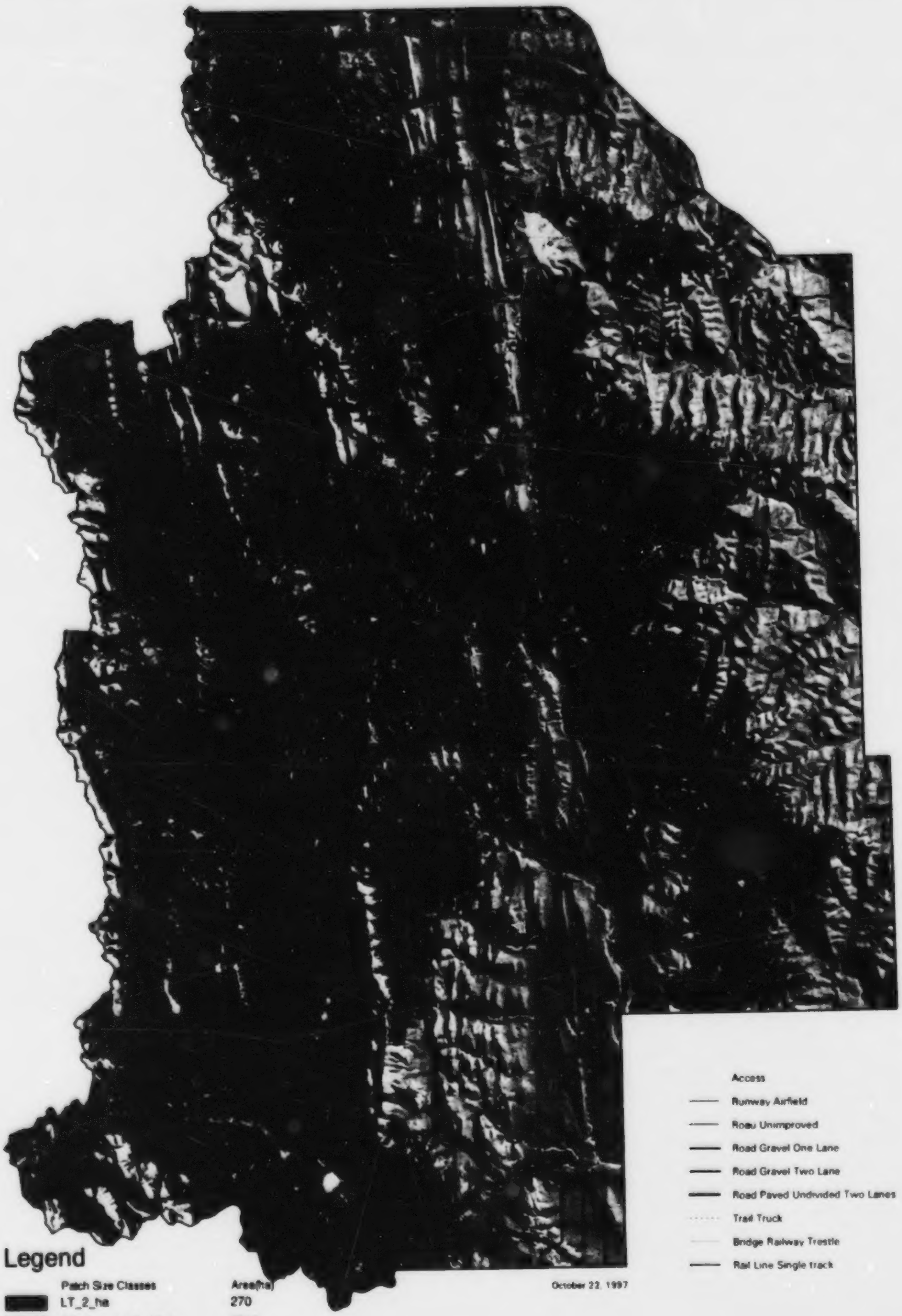
Alberta
Environmental Protection

5 0 2 Kilometers



LAND COVER

Southern Rockies
Landscape Planning Pilot Study



Legend

	Patch Size Classes	Area(ha)
■	LT_2_ha	270
□	GE_2_and_LE_10_ha	2813
□	GT_10_and_LE_50_ha	6718
▨	GT_50_and_LE_250_ha	6640
■	GT_250_and_LE_500_ha	3181
■	GT_500_and_LE_1000_ha	5048
■	GT_1000_and_LE_5000_ha	2632
□	GT_5000_and_LE_10000_ha	0
■	GT_10000_ha	242134

FORESTED ONLY PATCH SIZE

Access

- Runway Airfield
- Roau Unimproved
- Road Gravel One Lane
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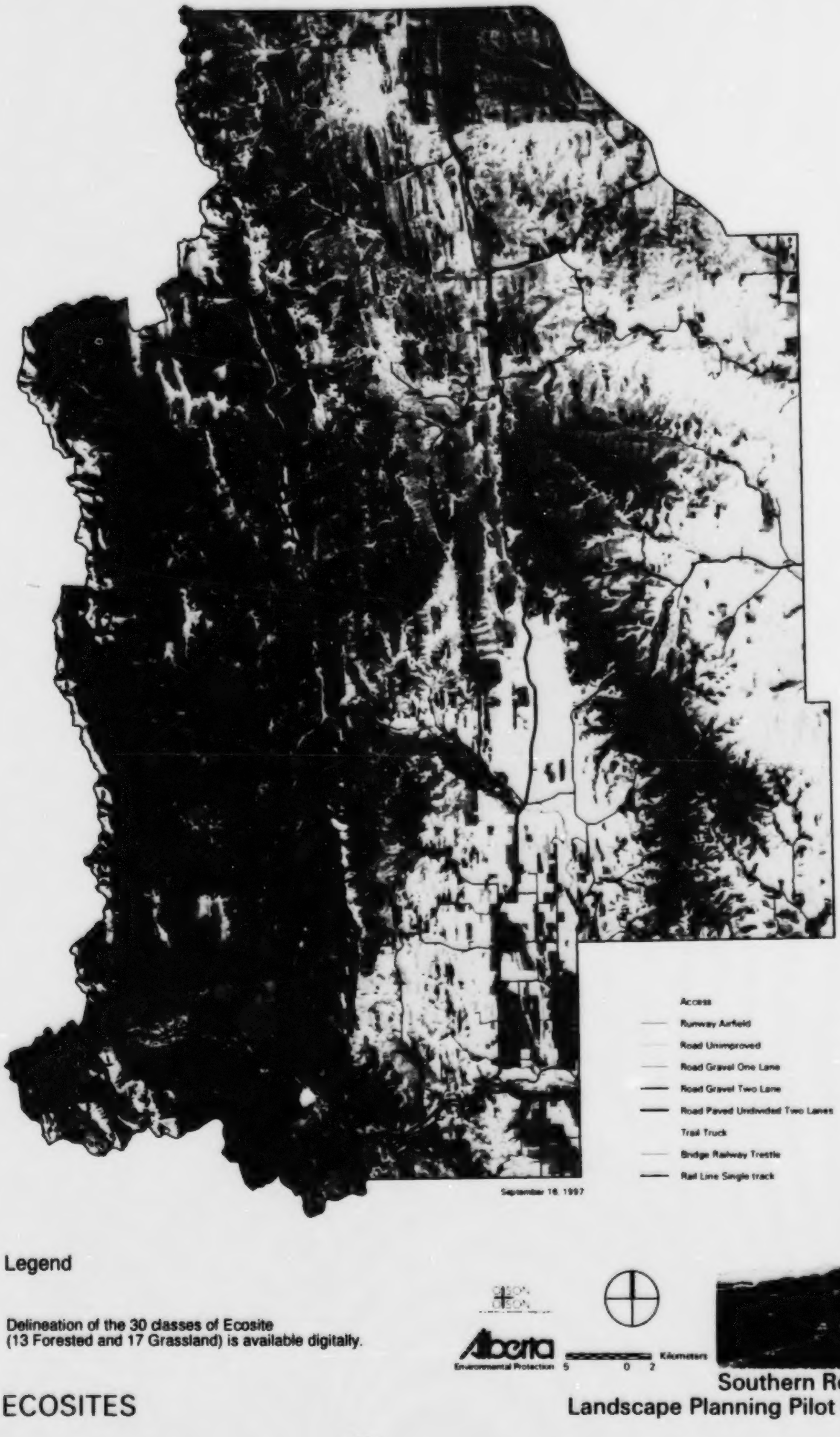
October 22, 1997

Alberta
Environmental Protection

5 0 2 Kilometers

Southern Rockies Landscape Planning Pilot Study


Access
Runway Airfield
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Bridge Railway Trestle
Rail Line Single track

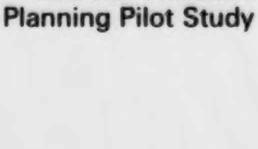
September 16 1997

Legend

Delineation of the 30 classes of Ecosite
(13 Forested and 17 Grassland) is available digitally.

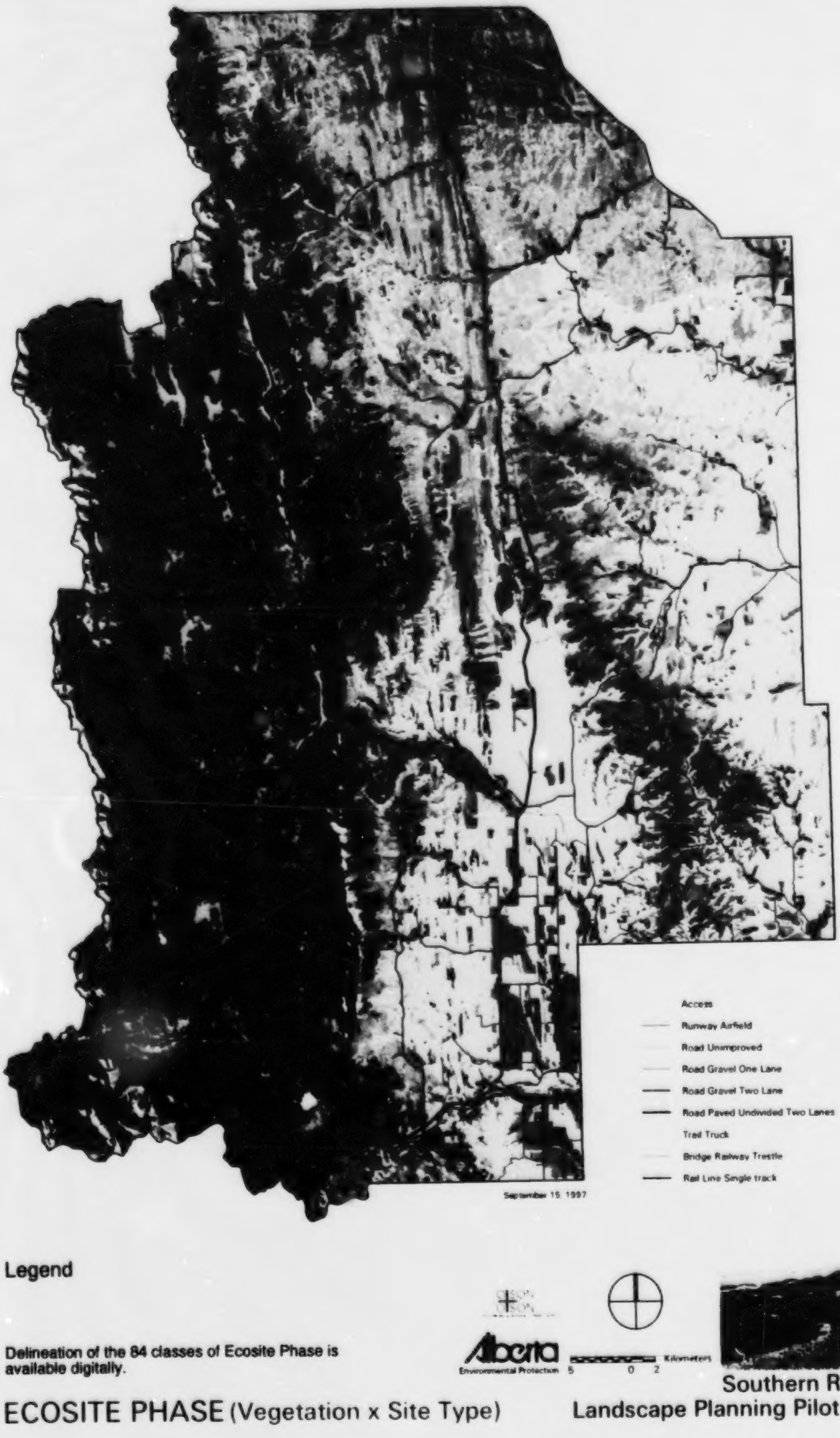
Alberta
Environmental Protection

5 0 2 Kilometers



Southern Rockies Landscape Planning Pilot Study

ECOSITES


Access
Runway Airfield
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Bridge Railway Trestle
Rail Line Single track
September 15, 1997

Legend

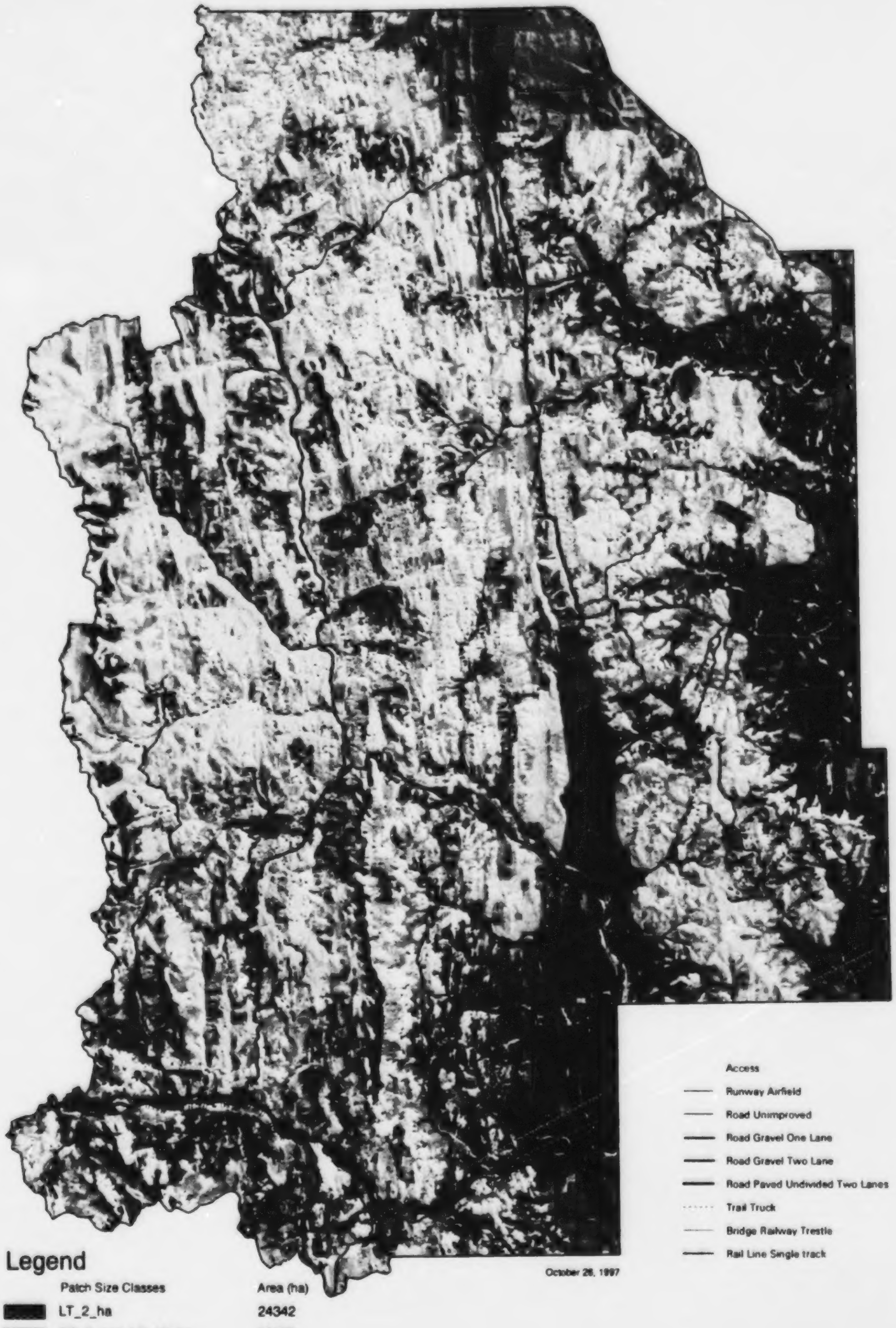
Delineation of the 84 classes of Ecosite Phase is available digitally.

Alberta
Environmental Protection

Kilometers
5 0 2

ECOSITE PHASE (Vegetation x Site Type)

Southern Rockies
Landscape Planning Pilot Study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Trail Truck
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Rail Line Single track

October 26, 1997

Legend

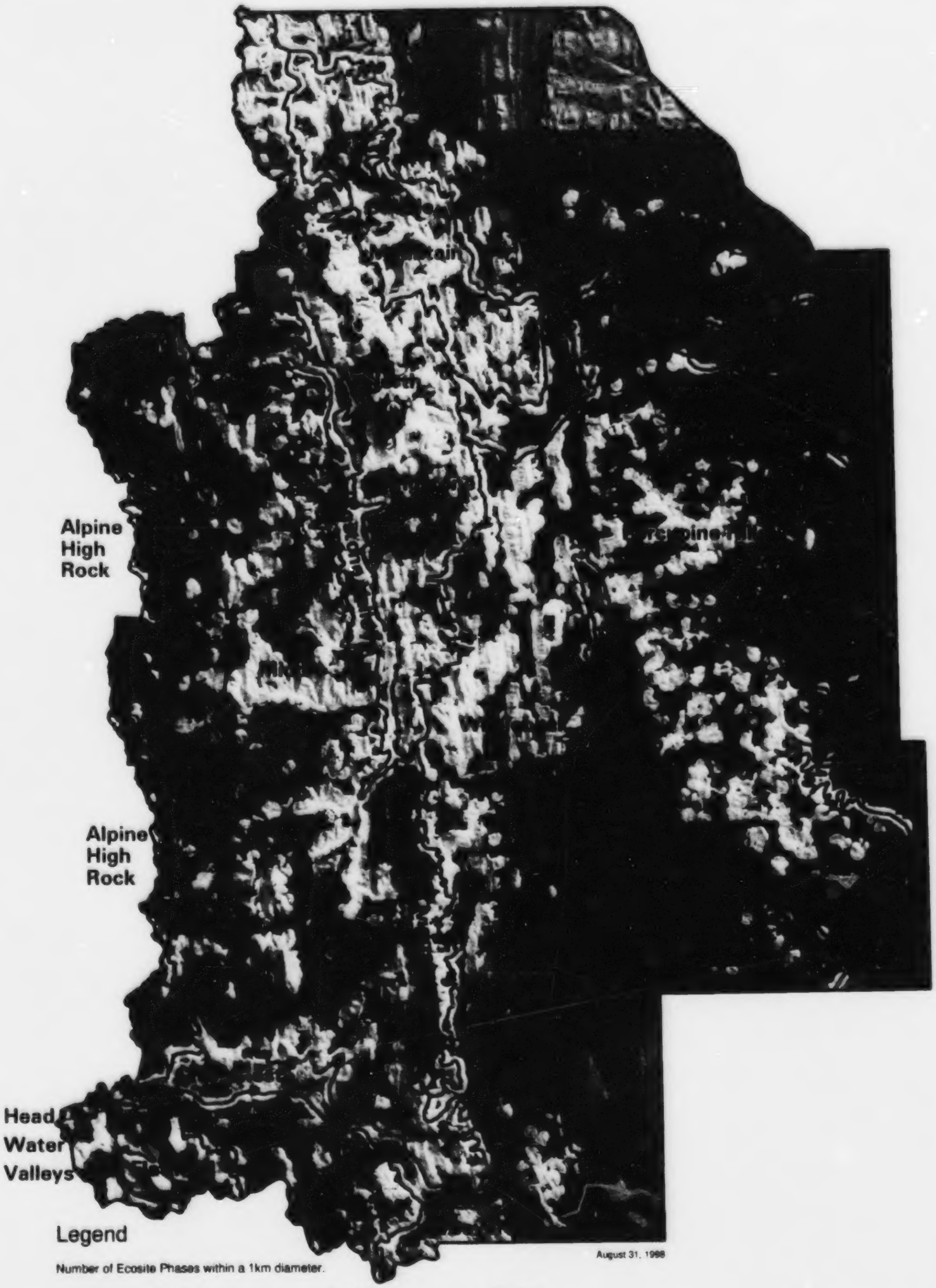
	Patch Size Classes	Area (ha)
■	LT_2_ha	24342
☐	GE_2_and_LE_10_ha	60459
☐	GT_10_and_LE_50_ha	101784
■	GT_50_and_LE_250_ha	85998
■	GT_250_and_LE_1000_ha	58357
▨	GT_1000_and_LE_5000_ha	50862
■	GT_5000_ha	55645

Alberta
Environmental Protection

Scale 1 : 300 000
Kilometers
5 0 2

CURRENT ECOSITE PHASE PATCH SIZE

Southern Rockies
Landscape Planning Pilot Study


Alpine
High
Rock
Alpine
High
Rock
Head
Water
Valleys

Legend

Number of Ecosite Phases within a 1km diameter.

		Area(ha)			Area(ha)			Area(ha)
■	1	34023	▨	9	33420	■	17	486
■	2	32825	▨	10	20228	■	18	239
■	3	40038	□	11	11983	■	19	111
■	4	51671	□	12	6655	■	20	40
■	5	65261	□	13	4009	■	21	7
■	6	67316	□	14	2699	■	22	1
■	7	63944	■	15	1696			
▨	8	50741	■	16	902			

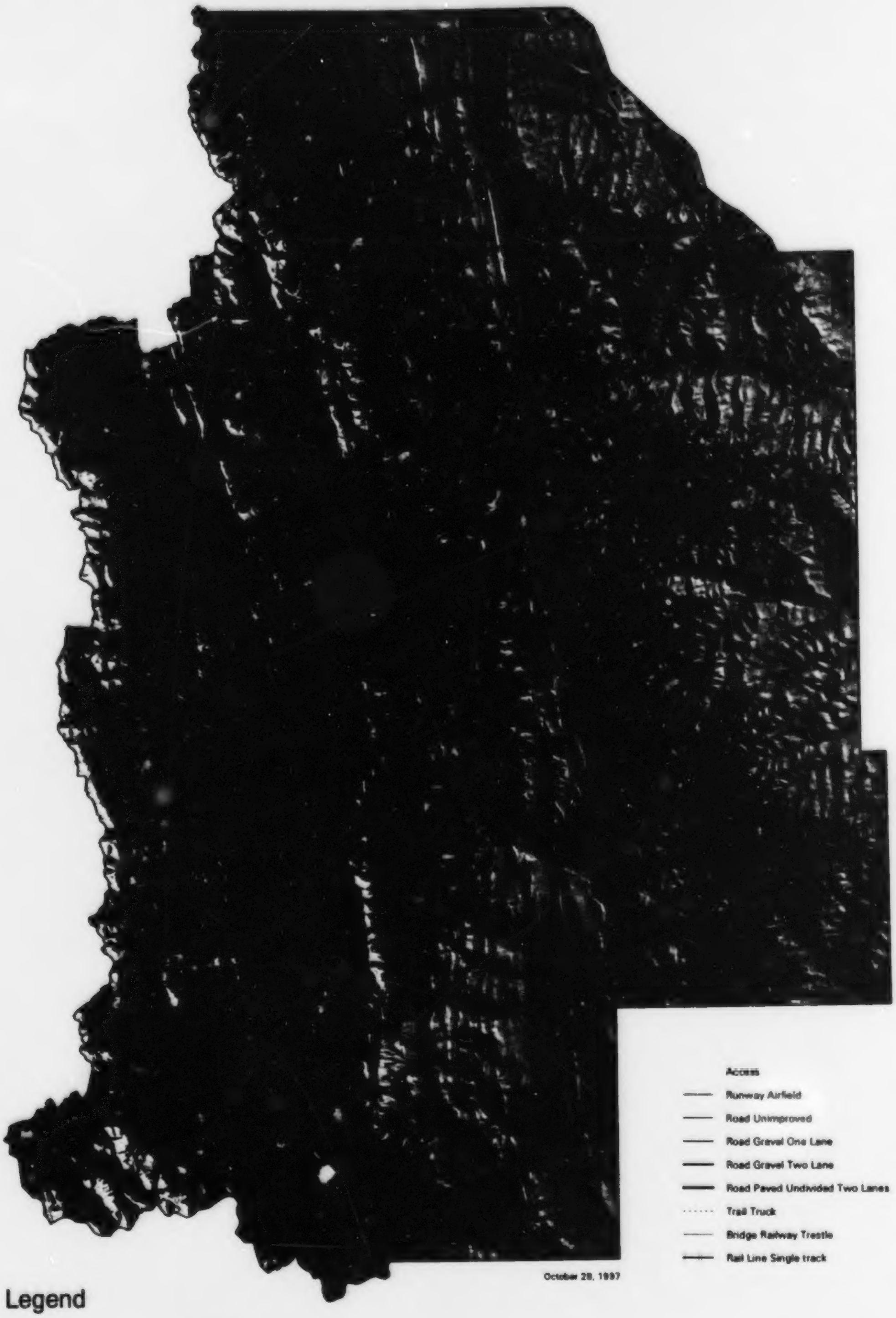
August 31, 1998

ECOSITE PHASE DIVERSITY

Alberta
Environmental Protection

Scale 1 300 000
Kilometers
5 0 2

Southern Rockies
Landscape Planning Pilot Study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Runway Airfield
Road Unimproved
Road Gravel One Lane
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Bridge Railway Trestle
Rail Line Single track

October 28, 1997

Legend

		Area(ha)
■	Least Circular	266065
▨	Less Circular	17245
□	Circular	813
■	More Circular	2
■	Most Circular	2

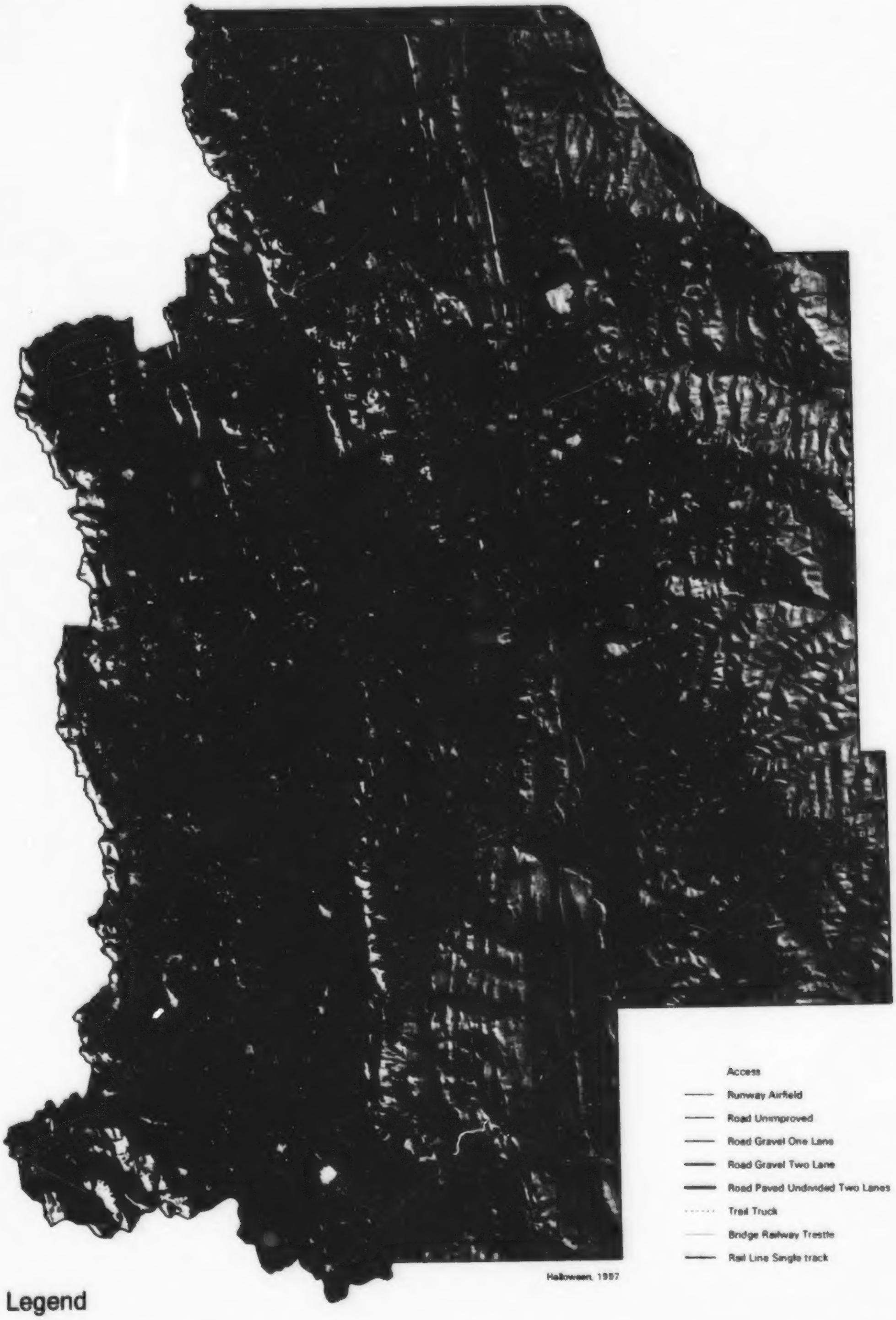
OLSON
OLSON

Alberta
Environmental Protection

Scale 1 : 300 000
5 0 2 Kilometers

PATCH CIRCULARITY - FOREST ORIGIN

Southern Rockies
Landscape Planning Pilot Study



Halloween, 1997

	Access
—	Runway Airfield
—	Road Unimproved
—	Road Gravel One Lane
—	Road Gravel Two Lane
—	Road Paved Undivided Two Lanes
⋯	Trail Truck
—	Bridge Railway Trestle
—	Rail Line Single track

Legend

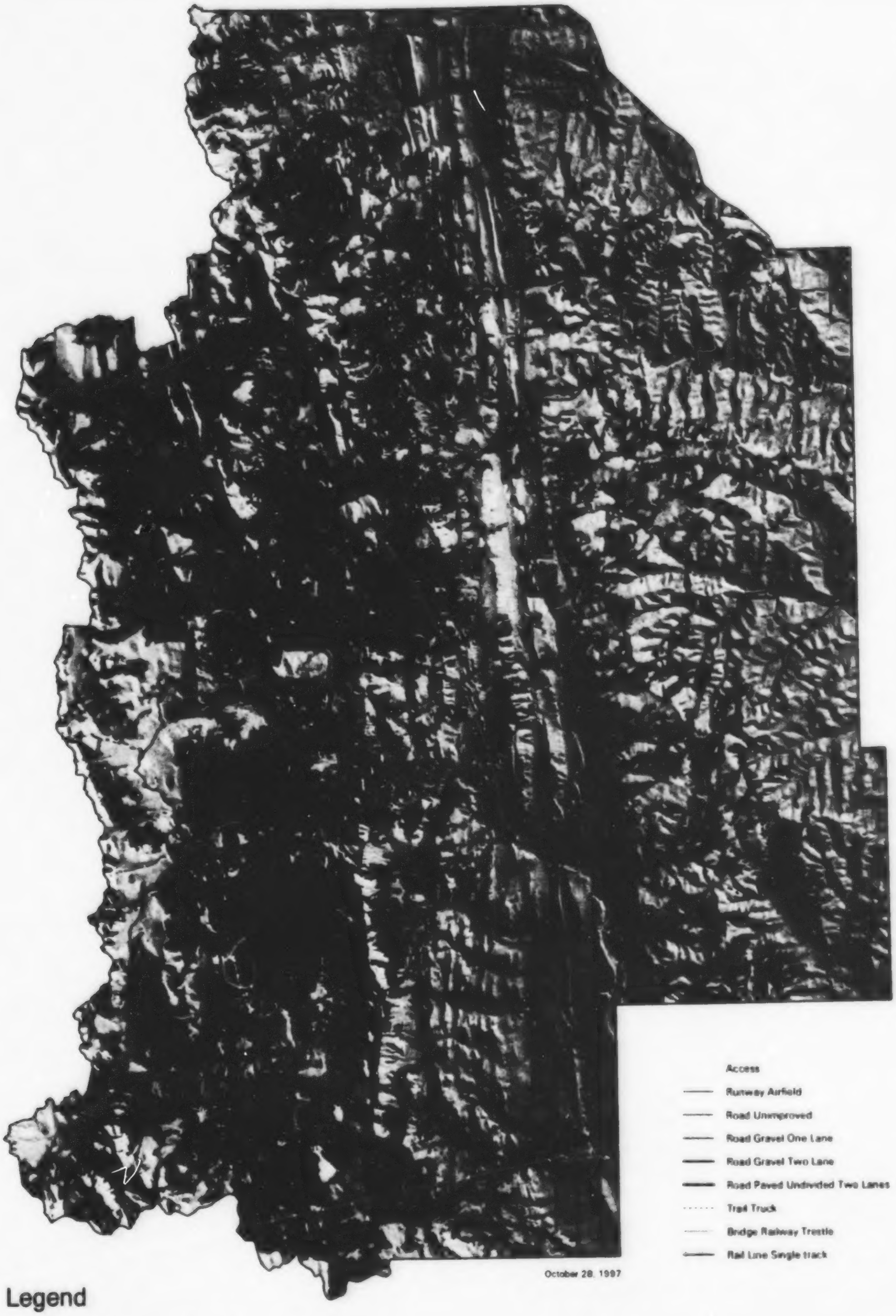
		Area(ha)
■	Least Circular	226526
□	Less Circular	38506
□	Circular	4404
■	More Circular	337
■	Most Circular	51

PATCH CIRCULARITY - ECOSITE PHASE

Alberta
Environmental Protection

Scale 1 : 300 000
5 0 2 Kilometers

Southern Rockies Landscape Planning Pilot Study


Access
Runway Airfield
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Road Gravel One Lane
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Rail Line Single track

October 28, 1997

Legend

		Area(ha)
■	Least Compact	167379
□	Less Compact	84335
□	Compact	20367
■	More Compact	1043
■	Most Compact	3

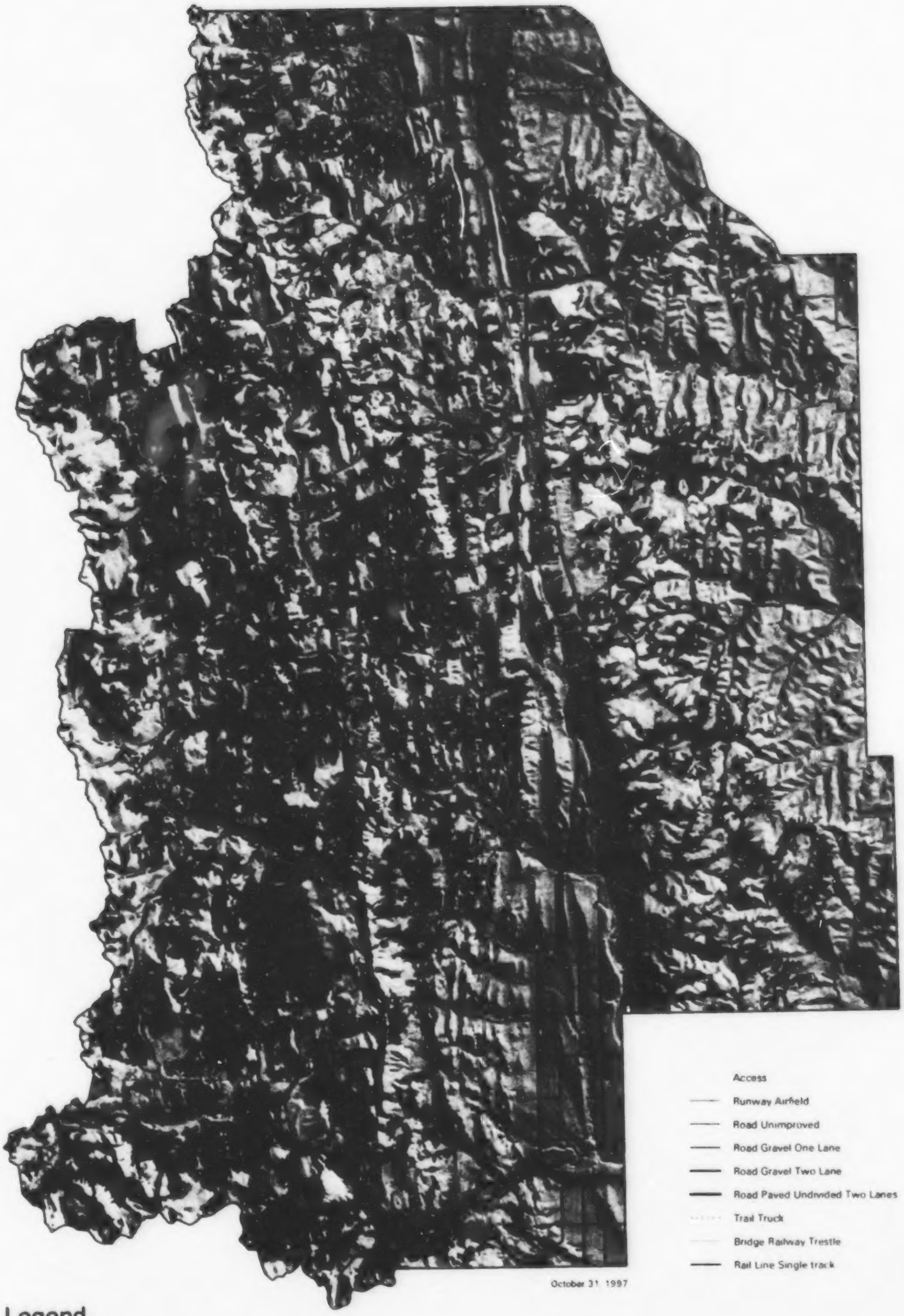
OLSON
OLSON

Alberta
Environmental Protection

Scale 1 : 300 000
Kilometers
5 0 2

PATCH COMPACTNESS - FOREST ORIGIN

Southern Rockies
Landscape Planning Pilot Study



Access

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- Rail Line Single track

October 31 1997

Legend

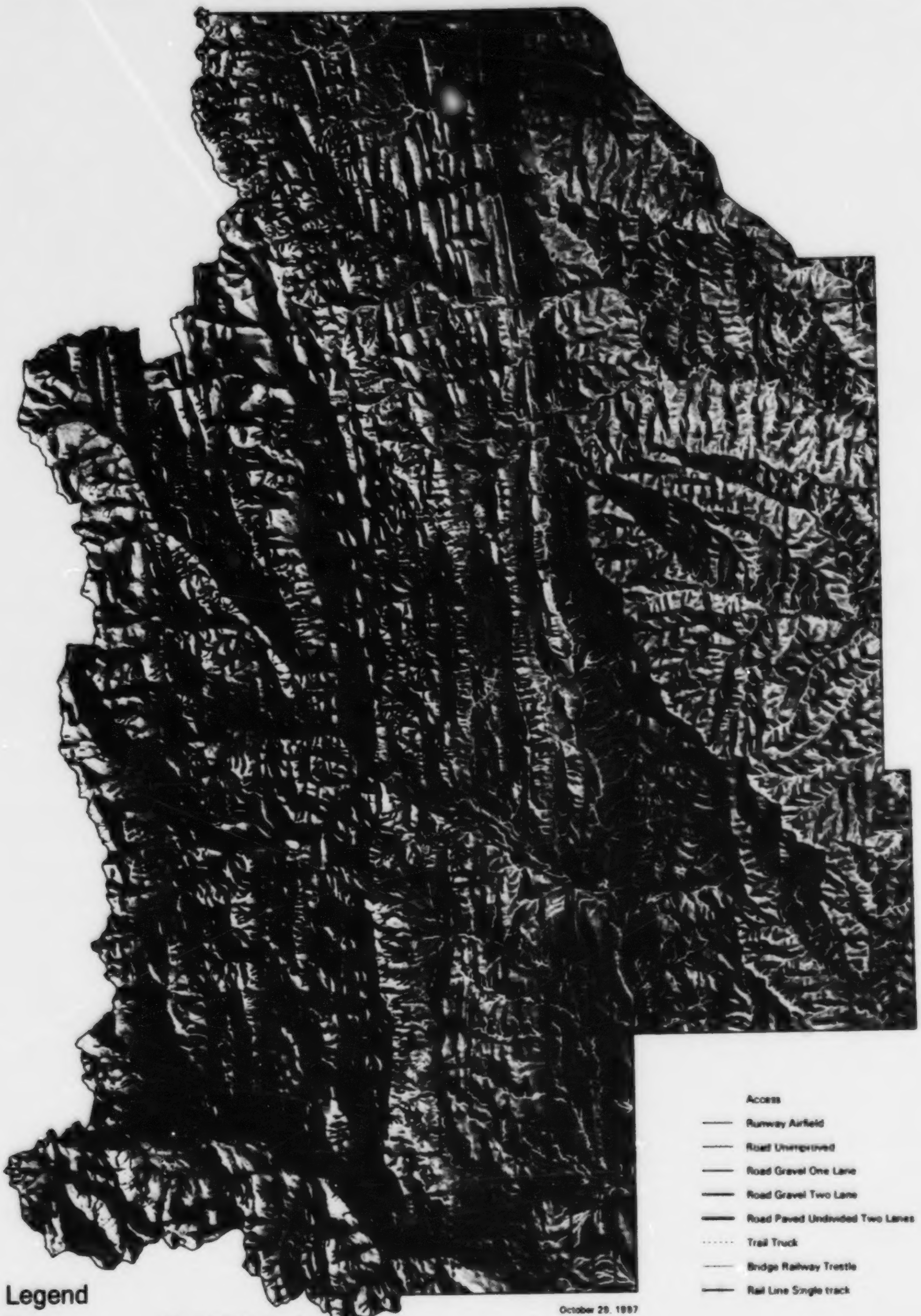
		Area(ha)
■	Least Compact	121609
□	Less Compact	104379
□	Compact	36901
■	More Compact	4631
■	Most Compact	305

Alberta
Environmental Protection

Scale 1 300 000
5 0 2 Kilometers

Southern Rockies
Landscape Planning Pilot Study

PATCH COMPACTNESS - ECOSITE PHASE



Access

- Runway Airfield
- Road Unimproved
- Road Gravel One Lane
- Road Gravel Two Lane
- Road Paved Undivided Two Lanes
- Trail Truck
- Bridge Railway Trestle
- Rail Line Single track

October 29, 1997

Legend

■ Pine
■ Spruce
■ Subalpine Fir
■ Douglas Fir
■ Whitebark/Limber Pine
■ Aspen
□ Balsam Poplar
■ Aspen Mixedwood
■ Balsam Poplar Mixedwood
■ Pine Mixedwood
■ Spruce Mixedwood
■ Subalpine Fir Mixedwood
■ Douglas Fir Mixedwood
■ Mixed Conifer (Spruce)
■ Mixed Conifer (Douglas Fir)
■ Mixed Conifer (Larch)
■ Shrub Wetland
▨ Shrub Meadow Open Mesic
▨ Shrub Meadow Open Dry
■ Shrub Meadow Closed Mesic
■ Shrub Meadow Closed Dry
▨ Rough Pasture Open Mesic
▨ Rough Pasture Open Dry
▨ Rough Pasture Closed Mesic
□ Annual Crops
□ Perennial Forage Crops
▨ Grassland Mesic
□ Grassland Dry
■ Gravel Pits/Surface Mines
■ Hamlets, Villages and Towns
■ Non-veg ROWs
■ Farmsteads
■ Rock Barren
□ Cutbank/Sand
■ River
■ Lakes/Ponds
■ Industrial Reclamation-Vegetated
▨ Forb Meadow
■ Herbaceous Clearcuts

OLSON
OLSON

Alberta
Environmental Protection

Scale 1 : 300 000
5 0 2 Kilometers

STREAM SIDE VEGETATION

Southern Rockies
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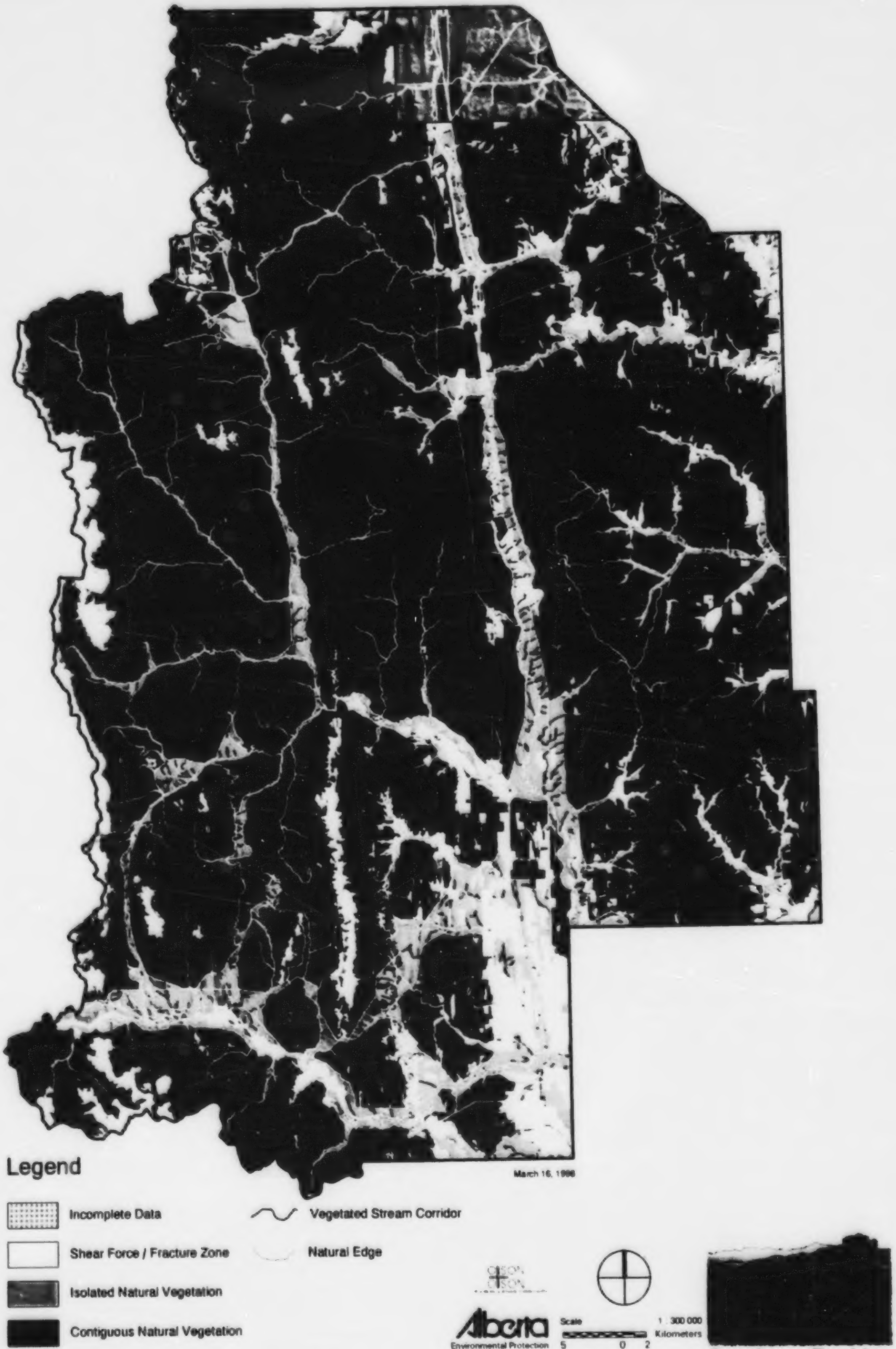
Legend
March 16, 1996
Incomplete Data
Shear Force / Fracture Zone
Isolated Natural Vegetation
Contiguous Natural Vegetation
Vegetated Stream Corridor
Natural Edge
Alberta
Environmental Protection
Scale
1 : 300 000
Kilometers
5
0
2

LANDSCAPE PATTERN

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